THE TELEGRAPHIC JOURNAL.

VOL. I.—NO. 7.

TO OUR READERS.

WE have much pleasure in announcing to our Readers that in answer to the increasing demand it has been determined to publish THE TELEGRAPHIC JOURNAL fortnightly, that is, on the 1st and the 15th of every month.

The change in frequency of publication will influence the arrangement of the Journal in some important particulars. But no part of the Journal will be removed. On the contrary, the STUDENTS' COLUMN (always nominally a column) will be greatly extended. The extension will include a series of papers for Students by Mr. ROBERT SABINE, C.E., and other eminent and practical electricians; and these papers will be cotemporary with the extension of the series of PAPERS FOR JUNIOR STUDENTS. In these columns it will be endeavoured to so explain the principles of the science of electricity as to render them easily understood by an ordinarily attentive reader.

A further addition will be a series of articles entitled "MATHEMATICS FOR NON-MATHEMATICIANS," in which will be explained the laws and principles of mathematical reasoning. The student will, it is hoped, be speedily enabled to undertake the application of the formulæ of physical laws.

Our notices of ELECTRICAL SCIENCE IN FOREIGN JOURNALS will be kept *au niveau* with Continental literature, and the papers will be given more often in detail.

To the investor and business man the more frequent publication of our CITY NOTES and SHARE LIST will add considerably to the value of the Journal as a commercial record.

We ask our READERS' recommendation as a Journal for the Student of Physical Science; as a mirror in which is reflected the actions of foreign scientists; and as a record of telegraphic business.

M. SORTAIS, in France, has invented an electrical device to be placed in the holds of vessels. In case of a leak or the entrance of too much water into the bilge, a current is established and a communicator is set in operation, signifying the fact to the commander and the officer of the deck.

EMPLOYMENT FOR WOMEN.

THE State Telegraphs, apart from their function as a means of communication, is a social institution of the highest importance. This importance, moreover, is derived not from its State influence, but from its *employés*. It is an institution offering a means of livelihood to a large number of women, of a class for which it is extremely difficult to find remunerative employment.

Women seeking employment may roughly be classed under three heads:—the domestic or other servant (as the word is generally understood); those engaged in the duties of buying or selling; and the class who find use for their time chiefly in educational pursuits, who are entirely unsuited by constitution or by taste for the work of the foregoing classes. This class is a terrible *bête noir* of the social economist. He finds there exist applicants for work of a higher order, which work it is his chief difficulty to provide. He finds, too, that the number of these applicants is continually increasing, and that their rate of increase is much more rapid than is the increase of means of employment for them. Consequently, when an opportunity occurs affording employment to thousands, a corresponding percentage of wealth is added to the country, and the economist is relieved of an incubus. Such a source of wealth results from the employment of female operators by the Post-Office Telegraph Administration. Their employment is advantageous not only to themselves, but more so to the State. The work of a telegraph office, as far as concerns transmission, is admirably suited to the patience, quick perception, and delicate touch of woman; and the State has its work done better in detail than would ensue from the employment of males solely. Also, because her social responsibilities are not so urgent as those of the other sex, the labour of woman is remunerated by a lower standard; and this lower scale of remuneration, while it supplies her wants, is not unimportant to her employers. It enables the administration to place a skilled clerk at each instrument, and by this arrangement the public gain in the speed with which their messages are transmitted. Further, the State can depend with greater certainty upon female than upon male *employés*, for the reason that the market for female labour is not open to the fluctuations attending the hire of male labour.

One very important advantage to the State accrues from what may be considered logically an accident. The business of a telegraph office is of two kinds—press-despatches and ordinary telegrams handed in by the public. The press-work, luckily, is transacted for the greater part during the night, and at a time when female labour would be attended

with considerable hardship. Then male labour is called for, both by the nature of the work and the time in which it is done.

The employment of women in the State offices opens the door to several classes of candidates. The one will seek admission, looking forward to the remuneration as a means of livelihood; the other, as a means of assistance in the case of a numerous family of brothers and sisters; and a few, we hope very few, as a means by which the desire to dress and "keep up appearances" may be fulfilled. The services of this last class are prejudical not only to the interests of their fellow-workers, but to that of the State itself; for without the stimulus of working for their daily bread there arises the danger of carelessness, a danger fatal to the service in which they are engaged; while the lower rate at which they are willing to work is but a famine allowance to their poorer sisters. This is the one danger the State is liable to, and practically it is an unavoidable danger. In every other view the opening afforded by the offices to a quick and industrious woman is beyond comparison. There are ladies in the employ of the service who are in receipt of salaries (to which as accomplished operators they are fully entitled) that attain very nearly the remuneration awarded to skilled male labour of a high kind.

It may be imputed to us that all this was apparent long ago. Perhaps so. But at no time has been the demand for female employment greater than now; and the reason is not difficult to find. Nearly every necessary of life has doubled in cost since a very short time. Numerous families can no longer be supported on small incomes, and the girls as well as the boys must work. Let us then keep in mind the opening for female employment afforded by the Government Service.

We have been asked to touch upon a point indirectly concerned with the ladies of the Telegraph department. It relates to their admission to the *Society of Telegraph Engineers*. Quoting a letter from an Associate of the Society which appeared in our last issue, "Have not female operators a right to be admitted as partakers of the benefits of instruction conveyed through the lectures and papers of the Society?" The answer may be found in the question itself,—in the two words "female operators." A Society should, we presume, partake of some of the characteristics of its denomination, and if an "Engineering" Society is the denomination in question, merely operators should be excluded (we believe they are) from becoming members, and should take rank as associates or visitors. Now a male operator should be somewhat of an engineer, and able at least to connect up his instrument; hence he would derive benefit from attendance at the Society's meetings. But we should be very sorry to put into the hands of our lady-friends a screw-driver or the pliers; and we think the Council and the Champion Associate will be of the opinion unanimously. But that the Society should deliver lectures to the operators (male and female), or to those interested in their avocation, would be much to be commended, and would meet with our hearty support.

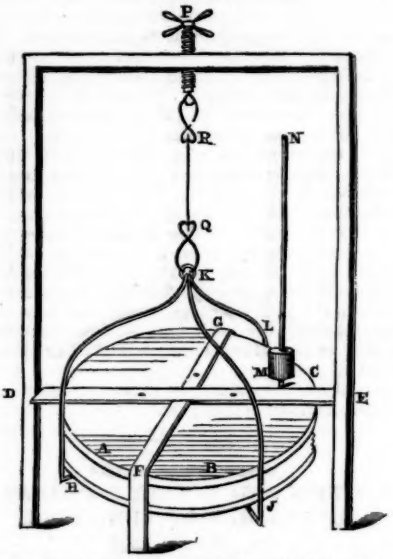
SIR WILLIAM THOMSON'S TEST OF IRON-WIRE.

At the discussion on Mr. Culley's paper "The Mechanical Tests of Iron-wire," at a meeting (April 9) of the Society of Telegraph Engineers, Prof. Ayrton described Sir Wm. Thomson's method of wire-testing.

There are three tests for ductility of wire, one by measuring the percentage of elongation before breakage, another by observing how many times a fixed length can be twisted round its own axis before it snaps. The latter of these, "the torsion test," as it may be called, Mr. Culley has shown gives more trustworthy results than the former. There is another test, however, which is a better criterion of the ductile power of wire, namely, that of bending it round a fixed diameter and unbending it again, the unbending being the really important part of the test, as the reverse action shows flaws that are not discovered by merely elongating or bending. Not unfrequently specimens of wire are seen that would not stand this latter test, but of which the percentage of elongation was even greater than the average percentage. It, therefore, appears that elongation tests really only measure the stretching power of wire, and not its power to bend. This bending and unbending test has, however, one decided disadvantage, that it only tests a very small piece of wire. In the case, however, where the bending and unbending test has been most extensively employed, namely, in testing the homogeneous wire for the cables of the Great Western Telegraph Company, it was found that there was frequently a variation in the quality of the wire in the same hank, so that neither the test of a few inches nor of some yards could determine absolutely the quality of the wire throughout the whole hank. Where, however, any doubt existed regarding the ductility of any particular hank, this bending and unbending test was applied not only to one piece, but to a number of pieces cut from each end of the hank. In addition, the tensile strength and the percentage of elongation of the end of every hank of homogeneous wire that was used was measured and recorded. The tensile strength and elongation were simultaneously measured on a piece 10 inches long. It was fully understood that it might have been better if a longer length had been employed, but the 10 inches was adopted on account of the strong opposition of the wire drawers to any other length. For straining the wire a hydraulic machine constructed by Sir William Thomson was employed. The machines commonly used for wire testing are either simply dead weights, in which case it is exceedingly difficult to apply the force gradually; or hydraulic pumps, which have the same objection as in the former case, and, in addition, are liable to

get out of order through faults in the valves; or lever machines, in which errors may arise from friction; or spring machines, which frequently give inaccurate results from the spring being out of order. Now in the machine of Sir William Thomson's, the force can be applied as gradually as is desired, and there are neither valves nor springs, nor is there practically the slightest friction. A short description, therefore, of this apparatus may perhaps be interesting. A B C is a disc of wood about an inch thick and 3 feet diameter, rigidly

FIG. 1.



attached to the two horizontal supports (D E) and (F G). H J is another similar disc of wood, supported by the three metal bars (K H), (K J), and (K L), the latter of which is only partially seen in the figure. This lower disc is attached to the upper one by a band of india-rubber, as in a bellows. M N is a glass tube, open at both ends, passing through a hole in the upper disc, and rigidly attached to it. The space between the two discs of wood is filled with water. When the handle (P) is turned, (K) will be raised; this would tend to compress the water in the bellows, which will consequently rise in the glass tube. The height to which the water rises tells the pressure per square inch on the lower disc; this multiplied into the area of this disc gives the whole strain on the piece of wire (Q R) under test. This instrument is, of course, independent of the actual quantity of water in the bellows. When the wire under test breaks the lower disc falls into a support placed underneath it, and so the india-rubber band joining the two discs is not strained. The object of enlarging the glass tube at its lower extremity is to necessitate the lower disc being raised an appreciable distance before the water begins to appear in the tube, otherwise as the diameter of the disc is very large compared with that of the tube, the water might begin to rise in the latter while still some portion of the disc were resting on the support placed underneath it, in which case of course the height of the water in the tube would not be a true measure of the strain on the wire under test. With this instrument tests can be made very rapidly, as the breaking strains are read off in pounds from a scale attached to the glass tube. The results are also obtained with great accuracy, as the instrument cannot possibly get out of order.

Of course there is nothing new in the principle of this apparatus, as it is simply that of the old hydrostatic bellows.

The elongation is measured thus:—A small scale is attached at its one extremity to the piece of wire under test, and near its other extremity there is attached to the wire a small pointer, which moves over the scale as the wire stretches. This is much better than measuring, as is frequently done, the distance between the clamps before and after testing, as this latter method frequently gives erroneous results from the slipping of the wire in the clamps

MULTIPLE TRANSMISSION BY THE SAME WIRE.

By M. MAYER,
Of the French Telegraph Administration.

THIS system of apparatus, based on the division of work, has for its end the utilisation of all the currents which in a given time can be made to succeed each other in a wire, so that several *employés*, each sending twenty to thirty messages per hour, may transmit them by the same wire, as is now effected by separate wires.—that is to say, each can, at will, receive or transmit, or rest; each can at any instant interrupt the transmission of his correspondent, without the least inconvenience to his neighbours. This may be attained without detriment to the methods ordinarily in use; and whilst the number of *employés* remains the same, the number of wires is reduced for the same amount of work. It may be accepted as a principle that the system reducing the number of wires to the least possible is the system showing the greatest progress.

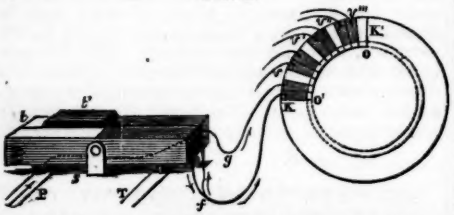
The number of transmissions that a telegraph line will carry varies naturally with its conductibility. It is generally admitted that with a speed of twenty-five messages per hour, on a Morse instrument, about five emissions of the current occur per second. Consequently, n being the sum of the currents which in a second can succeed each other in a conductor, $\frac{n}{5}$ represents the number of receivers which it is possible to establish upon a single wire, or the number of *employés* that can work at the same time. The multiple apparatus about to be described is constructed for four transmissions, and is served by four clerks. It revolves with a velocity of 75 turns per minute, presenting four letters at each turn. It records 100 messages in the hour, with 20 emissions of the current per second. This is less than a maximum result; for we learn by experience that all telegraph lines admit of many more than 20 emissions per second, to about a maximum of 500 per second.

As the apparatus is arranged for transmission, four keys are placed with their receivers upon a table, each receiver having its paper band. The printing arrangement is a quarter-spiral on which

revolves an inking-pad. A single clockwork movement, actuated by a weight and regulated by a conical pendulum, serves as the motor of all the receivers. The keys, as well as the receivers, are connected metallically to the earth-wire, and to the line-wire in the latter case, through the "distributor."

The *distributor* is a characteristic of the multiple telegraph. It is this which, in four equal intervals of time, directs the current of the battery successively towards each of the four receivers of the receiving station.

FIG. 2.



o o', Fig. 2, is a disc of metal, fixed and insulated. It has 48 divisions; 12 to the quarter of the circle, of which eight—grouped two and two—are connected metallically by a bundle of eight wires to the eight contacts of the keys; the others, to the number of four, are permanently connected to earth. There are, then, four cables of eight wires, which start from the four sets of keys and end in the distributor. The groups or double divisions are therefore sixteen in number, separated by intervals. The first half of a group, 1-48th of a revolution, gives place to a short contact; the entire group to one of double the length.

An elastic spring or rubbing-contact, *u*, mounted on the axis, traverses the circumference of the disc, and puts successively the four keys and receivers into contact with the line, so that the current emitted or received during the passage of the spring over one of the quadrants is directed through the receiver to which it corresponds. Each *employé* thus has the line at his disposal during a quarter of a turn.

It will be seen that the multiple telegraph, arranged upon the best division of the time utilised by successive currents, has nothing in common with the system of simultaneous transmission.

The *manipulator* is composed of eight keys or touches, four black and four white (arranged as in a pianoforte), connected between the battery and the earth. We have seen how they are connected to the divisions of the distributor. In touching a black key, the current from the battery lasts during a short period, and when a white key is pressed down during a long period, forming, in telegraphic language, a dot and a dash. In order to transmit a letter we touch simultaneously as many keys, black or white, as the letter to be reproduced has dots or dashes, taking care to start from the left key. A signal is transmitted the moment a letter is made. There is, in aid of sending, in front of each of the four keys, an excentric, the use of which is to raise after each letter a small rider, and this falling by its own weight produces a tick, beating the measure during which each *employé* may work.

Each of the receivers has for its printing mechanism the fraction of a helix, resembling an elongated spiral. The helix of the receiver and the rubbing-contact of the distributor make their revolutions in the same time. An inking-wheel revolves freely on each of the helices. The letters appear transversely upon the paper band (*i. e.*, at right angles to the ordinary Morse characters), the paper being raised to the writing-helix by the armature of the electro-magnet over which it passes. This transversal disposition of the letters presents a double advantage: it avoids confusion between consecutive letters, and reduces considerably the length of the paper band used for each dispatch.

The multiple transmission, then, depends upon the identical revolutions in the same time of certain portions of the apparatus at distant stations. This is effected by the aid of a conical pendulum and a regulating system, by which a correcting current is transmitted every second. Further, it is arranged that the line should be put to earth at both extremities after each emission of the current.

The apparatus has been in use for some time in France, between Paris and Lyons, every day from 11 o'clock in the morning until 6 in the evening, under the direction of an official Commission, with the following results:—The maximum per operator has been 28 messages per hour, with a maximum for the four operators of 110 messages the hour; while a Morse gives only 18 messages per line, and a Hughes' type printer 22 messages the hour. And that relatively the work done by this apparatus is to that of the Morse as 4 : 1, and of the Hughes as 2 : 1.

A multiple transmitter is shown in action at the Vienna Exhibition this year.

OBSERVATIONS ON THE

DURATION AND MULTIPLE CHARACTER OF FLASHES OF LIGHTNING.*

By OGDEN N. ROOD,
Professor of Physics in Columbia College.

ARAGO has classified the different forms of lightning under three heads:—1st, linear zigzag flashes; 2nd, flashes appearing as a broadly diffused light (sheet lightning, heat lightning); and lastly, the rarely occurring discharges which are seen as slowly moving balls of fire. That the first form is due to the production in the atmosphere of a gigantic electric spark has since Franklin's time been disputed by no one, and as far as I can ascertain, the majority of physicists and meteorologists *suppose* that flashes of the second form are due to the same cause, their light being seen either by transmission through or reflection from the clouds.

Immediately after my own experiment I arranged a small train of toothed wheels driven by a spring, so that it should be capable of rotating a circular pasteboard disc which was provided with four *open* sectors of 3° each. This apparatus was constantly near me ready for use, but an entire year elapsed before an opportunity occurred. I noticed then, upon one occasion, about midnight, that my room was from time to time illuminated by lightning-flashes, whose duration seemed as great as an entire second; and upon making an examination with the rotation apparatus, it was found that each flash consisted of a considerable number of isolated and

* Abstracted from "Amer. Journ. of Science and Arts."

apparently instantaneous electric discharges, the interval between the components being so small that to the naked eye they constituted a continuous act. The lightning was of the second form, and, judging from the accompanying thunder, was not very distant; but it soon ceased, so that I was not able to gain any further information.

The next observations were made late one evening in last June. The storm was at a greater distance, and, as before, the clouds were illuminated by unseen flashes. The storm allowed me no time for the study of the components of the flashes.

During the following month, at about the same hour in the night, I again observed, near the horizon, clouds illuminated by a more distant storm. The multiple flashes were once more noticed, and when the disc revolved at rates of five to ten revolutions per second, the light from the four sectors was quite often drawn out into a circular streak, which extended around its entire circumference, showing a steady and continuous duration of some of the components for at least 1-20th to 1-40th of a second.

A thunder-storm occurring at 2.30 a.m., on July 30th, gave a better opportunity. The observations, like the preceding, were made at Peacedale, R.I. Previously I had arranged the apparatus for the measurement of greater intervals of time, by attaching to one of the axes a disc with a single open sector, which could be rotated at quite low rates, the terminal axis being provided with a fan. When this disc was revolving at the rate of 2·04 turns per second, the open sector was several times observed to make at least two complete revolutions during a single flash, which gave a total duration for the act in those cases of about one second. The total duration was, however, quite variable, and often amounted only to a small fraction of a second.

With a disc having only a single narrow, open sector, and making from 12 to 15 revolutions per second, the multiple character of the flashes was then studied. The flash consisted of a considerable number of isolated electrical charges, which sometimes were executed with so much regularity as apparently to cause the disc to rotate backward, with a slow motion, through 30° or 40°, the cause being analogous to that involved in the phenomena of the stroboscopic discs. Several times, also, instead of seeing the sector single, I noticed that it had a form approximating to that of the letter X or V, which evidently was due to the circumstance that almost involuntarily my eyes had glanced from one side of the disc to the other, thus giving rise to a combination of distinct visual impressions.

Next, for the purpose of examining the individual constituents of the flash, I placed on the terminal axis a circular disc, each quadrant containing a square opening of about 5°; and when this was revolving eleven times in a second, sometimes the flash was seen to consist of a small number (three to six) of apparently instantaneous discharges, the form of the square not being at all distorted. The same was afterward noticed with a velocity as high as 22 revolutions per second, and if the areas of the squares had been doubled this could not have escaped my attention, but as in many cases nothing of the kind was seen, it follows that the duration of the apparently instantaneous constituents was less than about 1-160th of a second.

On the other hand, sometimes the continuous duration of the constituents was such that the whole circumference of the disc was surrounded by a bright or faint ring of light, according to the original luminosity of the flash, which gave a duration for the continuous act at least as great as 1-44th of a second.

The last set of observations were made at Stockbridge, Mass., on the evening of August 25, 1872. The thunder was heard quite loudly, and direct zigzag flashes were occasionally seen; rain also fell. The disc employed on this occasion had only *one* square opening, the sides of which were 7 m.m. (corresponding to about 12°), these dimensions having finally been found preferable. The rate of rotation was kept nearly constant by winding up.

The flashes were usually multiple, and the duration of the components was often or generally quite long, being as great as 1-20th of a second, if not longer; the brilliancy of the ring of light was considerable, and showed no signs of falling off throughout its whole extent. It was again noticed that when the duration of the earlier components had thus been considerable, the last act (or certain acts) were instantaneous. Eight or ten times it was fairly noticed that the components of certain flashes were to all appearance instantaneous, there being no distortion in the shape of the square. If its area had been increased by one-half this could not have escaped my attention, and would have implied a duration of 1-260th of a second. A number of uncertain observations were made, leading to a duration of the components, in some cases, of from 1-300th to 1-600th of a second, and, finally, in two cases the breadth of the square was distinctly doubled, giving a duration of about 1-600th of a second.

It is evident from the foregoing that the nature of the lightning discharge is more complicated than has generally been supposed; it is usually, if not always, multiple in character, and the duration of the isolated constituents varies very much, ranging from intervals of time shorter than 1-1600th of a second up to others at least as great as 1-20th of a second, and furthermore, what is singular, a variety of this kind may sometimes be found in the components of a *single* flash. The long durations of certain constituents of the flash induced me afterward to make some experiments with a view of ascertaining the cause of this singular and unexpected phenomenon; and although the results are negative in character, still it may not be amiss briefly to mention them. I constructed a glass tube similar to those used for studying the spectral lines of rarefied gases, and having connected it with a mercurial air-pump, rarefied the ordinary air contained in it. A Leyden jar, with a coating of 738 square centimetres, was connected with the tube, and a spark micrometer was introduced into the circuit, so as to interrupt it, and thus to cause the jar fairly to charge and discharge itself, as otherwise the prolonged discharges of the induction-coil made their appearance. The tube was placed in front of the rotation apparatus used by me in investigating the electric spark, and its appearance studied at tensions from 1 m.m. upward, till the resistance became so great as to cut off the discharge. In every case the light appeared to be instantaneous,—that is, its duration was so small as to preclude the idea of its affording an explanation of the long intervals occurring in the case of

lightning flashes. Of course, in all these experiments, the actual rate of the mirror was quite low. I then repeated the same experiment with the vapour of water, at a tension of about 15 m.m., with the same result.

Afterward a jet of steam was directed across the path of the electric spark in the free air, with a similar negative result. Finally, thinking that possibly the rain might in some way be concerned in the production of the prolonged durations, while sparks 10 to 15 m.m. in length, obtained from a smaller jar, were traversing the ordinary atmosphere, fine watery spray was directed across their path by the use of an "atomiser," without sensibly increasing their duration. These experiments may be explained by the greater volume of the atmospheric electricity, but suggest, on the other hand, the possibility of a real prolongation of some of the constituents of the flash.

It will be seen that additional observations are still desirable, and hence I wish to describe more definitely the apparatus which after many trials answered best, as well as to suggest one of a more perfect form. At the outset I found it necessary to discard the plan of viewing a figure painted on an opaque disc, which seems to be the only one which had occurred to other physicists, its indications being uncertain, and the loss of light so great that it was impossible to observe even the *presence* of the less prominent constituents of the flash. It is advisable, then, to use a black or *grey* opaque disc, about 100 m.m. in diameter, with an *open* sector, and, as has been shown in the present article, this is the only mode by which, thus far, actual measurements of the duration have been obtained. The multiple character of the flash renders it unadvisable to use more than one sector. The best form for the shortest and longest durations is that of a square, with sides of from 7 to 10 m.m.; for medium durations the same form can be retained with larger dimensions, and for examining the multiple character of the flashes simply a long narrow sector of 1° or 2° is preferable. A spring rotation apparatus, on account of portability, may be used, being so contrived as to admit of rates from one revolution up to twenty or thirty per second. This should be provided with some contrivance by which the observer might always be able to ascertain to what extent the clock-work at the moment had run down, so that the rate of the disc's rotation could afterward be found, without at the time interrupting the observations. A simple plan is to wind on the cylindrical portion of the key a string, which passes downward through the base of the instrument, knots being tied on it so as to indicate the number of turns already made by the slowest wheel.

The following is a more elaborate form, with which more accurate results could be attained, and which probably would reveal details quite beyond the reach of the simpler apparatus. A circular disc of the kind just mentioned is to be set in rotation by clock-work run by a weight; an image of the disc, of the natural size, is to be formed on a vertical plate of ground glass by an achromatic lens of 7 or 8 inches focus and of large aperture ("portrait combination" from a photographic camera). An opaque circular screen is to be placed around the edge of the disc so as to cut off all stray light, which I found in my experiments very annoying. The observer placed behind the ground glass will measure simply with a pair of compasses the length, &c., of the streaks, and the difficulty of accommodating the eyes for the image will in great part vanish, from the circumstance that the hands will be resting on the ground glass where the images are expected.

ON THE INTENSITY OF AN INDUCED GALVANIC CURRENT.*

By SELIM LEMSTRÖM,
Professor of Natural Philosophy in the University of Helsingfors.

THE effects of an electrical current can be classed under two groups, one of which includes the galvanometrical and chemical results, and the other the electro-dynamical, thermal, magnetic, physiological, and purely mechanical. When a current of short duration passes through a galvanometer, it is well known that the effect is proportional to the quantity of electricity which is developed during the continuance of the current. If i is the intensity of the current—or the quantity of electricity developed in a unit of time, say a second—and t the time of duration of the current, then the effect, ϕ, is represented by the equation—

$$\phi = k\int_0^t i\,dt$$

If, on the other hand, a similar current passes through an electro-dynamometer, the effect is expressed by—

$$\phi' = k'\int_0^t i^2\,dt$$

These are the two characteristic formulæ of the above-mentioned groups; and if by means of them we seek to determine the intensity of an induced current, the total effect of which has been simultaneously measured both by the galvanometer and the electro-dynamometer, we obtain an expression for this which corresponds to the mean intensity of the whole current.

The case becomes different, however, if we interrupt the induced current for a short period of its continuance; we obtain then on the galvanometer an effect proportionate to the quantity of electricity which has been developed during the continuance of the current from its commencement to its interruption. If we continue in this way to interrupt the current repeatedly at unequal intervals, we obtain a succession of effects which represent the quantities of electricity corresponding to these different intervals. If $i^\circ, i', i'', i''',$ &c., denote the the mean intensity of the current, and t°, t', t'', t''', &c., the corresponding intervals of time, then the effects are represented by the products $i^\circ t^\circ, i't', i''t'', i'''t'''$, &c. We arrive in this way at a means of determining and graphically representing the variations in the intensity. For if, taking co-ordinate axes, we set off the given intervals as abscissæ and the corresponding effects as ordinates, we obtain a row of points, the curve passing through which indicates the law of the quantities of electricity developed. Pursuing this train of investigation we obtain a

* Condensed from "Poggendorff's Annalen."

series of values for the true intensity of the current, the variations in which can only be accurately represented by another curve, the abscissæ of which are the times t, and the ordinates the values of i.

Professor Lemström has applied the above method to determine the course of the intensity of an induced current, his especial objects being to ascertain the influence which primary currents exercise upon an induced one, and the manner in which the latter behaves when the resistance of its circuit is increased, as is the case when a granule of soft iron is placed in the induction coil. The following are some of the results of his experiments:—

1. *The opening or indirect induced current.* In the first half of the unit of time—that is to say in 0·0001 second—the intensity indeed attains the maximum, but falls therefrom quite suddenly, so that at the beginning of the second unit it has sunk to a ninth of the maximum, whereupon the time-intensity curve runs asymptotically with reference to the axis.

2. *The closing or direct induction curremt.* The intensity of the current increases very slowly at first, but after about 0·0007 second, a maximum is suddenly attained, whereupon just as suddenly—that is to say, within the same unit of time—it falls to about one-eighth or one-ninth of the maximum, in consequence of which the curve approaches the axis of x asymptotically.

When the resistance of the circuit of the inducing current is increased, the intensity is diminished, and the effect is at once perceived on the induced current.

When resistance is interposed in the circuit of the induced current, the opening current only indicates a marked decrease of intensity at the maximum, but the curve in other respects preserves its form. Under similar circumstances the intensity of the opening current increases somewhat, but with this exception, the curve remains as before. When the resistance is interposed in the form of a coil of wire, both currents show an equal intensity; the whole curve runs along the axis of x, and indicates a scarcely appreciable maximum for both currents.

When a granule of soft iron is placed in the induction-coil, the effect is so much increased that the power of the battery must be reduced, and then the intensity curve of the closing current is quite flattened away, but the opening current yields a curve which indicates the course of the intensity. It appears from this experiment that the induced current under certain circumstances develops an amount of electricity four times as great as that of the inducing current.

It is obvious that the results obtained by means of these experiments may be advantageously applied to elucidate the extraordinary electrical effects which have been lately produced with magneto-electric, electro-magnetic, and especially with electro-dynamical apparatus.

Telegraphy in Western Australia.—The governor of Western Australia has been pleased to appoint Mr. J. C. Fleming to be superintendent of telegraphs for that colony. The Western Australian Government has fixed its telegraphic tariff at 1s. per ten words between any two stations throughout the colony. Western Australia has now been established as a colony for 43 years, and appears to be, at last, coming to something.

Electro-Physiology.

ELECTRO-THERAPEUTICS.

The physiological applications of electricity will not be complete without an account of the recent use of the electrical fluid as a therapeutic agent. We purpose briefly reviewing the most prominent cases chronicled at home and abroad, going back sufficiently far to include the records of the year, and in the future giving abstracts as incidentally may be best.

In the *Berliner Klinische Woschenschrift* (No. 39, 1872), Dr. M. Meyer records several cases of treatment of Grave's disease by galvanising the cervical sympathetic during 20 to 84 sittings, a weak current being passed through the sympathetics; one pole being applied to the submaxillary region, and the other to the eyelid of the closed eye. The time of galvanising varied from two to three minutes. The results recorded are extremely satisfactory, all cases having been cured.

The *New York Medical Record* contains, in the latest volume, the continuation of Dr. J. Byrne's observations on the use of the electric cautery in uterine surgery. Particulars are given of 93 operations, 30 of which were malignant cases. In 15 cases the use of the cautery was attended with beneficial results of a high order; and Mr. Byrne advises its employment in all cases of cancer and fibroid tumours.

From Professor Groh, of the University of Olmutz, Austria, we have one of the most important contributions to medical electricity. He has confined his operations chiefly to electrolysis. The chief methods of treatment in electrolysis have hitherto been due to Dr. Althaus, but Dr. Groh modifies these methods, inserting the positive as well as the negative electrode into the tumour. The battery employed is Frommhold's, and the patient is subjected to a powerful current (under chloroform) or to a gentle current of considerable duration. Needles of steel, zinc, or platinum are employed to pierce the tumour and serve as electrodes. In the case of zinc needles the metal is dissolved by the nascent chlorine, affording secondary as well as primary electrolysis. Dr. Groh proceeds to describe the process of application, and then to discuss the advantages and disadvantages of electrolysis. The disadvantages he enumerates to be, that large tumours may be destroyed without the loss of a drop of blood, a matter of moment in cases of prostration of strength; and that the eschars formed are rapidly thrown off, the reaction being slight locally and generally, and the granulation copious. Two peculiar cases were very successfully treated. In the first, a case of cancer of the rectum, both the smell from ulceration and the pain disappeared after the first electrolisation. The second case was one of epithelioma of the lip, with a considerable swelling of the right submaxillary gland, which disappeared a few days after the first application.

The disadvantages are stated to be the following:—Primarily the battery is expensive. In large tumours many applications are necessary. And Dr. Groh thinks that in many cases the knife would be equally devoid of danger, but that electrolysis has special advantages with given cases. Prolonged electrolysis

is not liable to these objections. The current (from a Daniell's battery) being feeble chloroform need not be administered. By this process a tumour of almost any size may be destroyed, and in one case of myxosarcoma of the left leg, of the size of a child's head, the electrolisation was effected during the period from Jan. 27 to Feb. 13, and on April 15 the patient was discharged cured.

Dr. Onimus, in *Le Movement Medical*, Feb., 1873, describes the action of the electric current upon the muscles of a murderer who had recently suffered execution.

In the *Quarterly Journal of Psychological Medicine*, No. 3, we have a communication by Dr. George M. Beard, in which he states his belief in the possibility of affecting diseases of the skin by central galvanisation alone without application to the diseased surface. Chronic eczema, prurigo, lichen, and acne have been cured by him by placing the negative pole at the pit of the stomach, and passing the positive over the head, neck, and spine. As to the possibility of improving the condition of debilitated children, he affirms that "I am accustomed to apply the faradic (induced) current all over children and very young babies in all cases where lack of appetite, flabbiness, or emaciation, or simple nervous irritability indicates a chronically depraved nutrition of the general system."

In the *Practitioner*, for January, 1873, Dr. Poore has a paper in which he shows, by experiments with the dynamometer, that the passage of the current increases the susceptibility of the muscles to the stimulus of volition. With galvanism eight successive squeezes of the instrument gave 477 lbs., and without galvanism only 388 lbs. Dr. Poore advises the combination of galvanism with voluntary movements.

Students' Column.

Absorption.

Before we proceed to discuss the practical methods of electrostatic measurement, we must turn our attention for a short time to the phenomena of absorption or electrification. We have previously spoken of the *specific inductive capacity* of an insulator or dielectric, and its influence upon the capacity of a condenser. It may be added, that the specific inductive capacity of a dielectric is the constant by which the capacity of a condenser insulated by air must be multiplied when we substitute another dielectric, as india-rubber, for air. The constants for those substances in common use in telegraphy are—

Paraffin	1·98
India-rubber	2·8
Hooper's vulcanised ditto	3·1
Willoughby Smith's gutta-percha...	4·2
Mica	5·0

But these numbers, if we require accuracy, are to be considered as approximate, for the reason that the phenomena of absorption here comes into play. To understand the meaning of the term "absorption by the dielectric," or, as some writers say, "electrification" (the latter term is open to the obvious objection of confusion), let us make an experiment. We must take a battery, a galvanometer, and a condenser. We connect one pole of the battery to one side or coating of the condenser; the other pole to one terminal of the galvanometer. The second terminal of the galvanometer we connect to the remaining coating of the condenser. Thus we have a circuit broken only by the insulator or dielectric of the condenser. For the convenience of making and breaking contact we will insert in the circuit a contact-key. Now, being ready, we make contact, with the result that the needle of the galvanometer is suddenly deflected. But there is something more to be observed. The deflection has been caused, of course, by the passing in of the electricity from the battery to fill the condenser; and we might suppose that when our condenser (which may contain a certain quantity) is full, the electricity would cease to pass in, and the needle would be deflected no longer. This supposition would be correct to a certain degree. The first charge rushes into the condenser with great rapidity, but the flow will not quite cease for some hours. Why is this? As far as we can see, it is because the electricity continues to be absorbed by or to soak into the dielectric.

Now if we measure the quantity of electricity passed into the condenser in a given time, we shall find that condenser will yield up the same quantity in the same time; that is, if after charging the condenser for ten minutes with a quantity nq, we connect the two coatings of the condenser by a wire, we shall find that, to empty it of the quantity nq, we shall have to wait ten minutes, if the resistances in circuit be equal in both cases.

Taking this phenomenon into consideration, the capacity of a condenser is generally measured by the quantity of electricity it will receive at the first contact. We also know now how it is that the *residual* discharge, as it is termed, is obtained. If we discharge a condenser, and then leave its poles unconnected, there can be obtained, after a short time, a second discharge, and by proceeding in the same manner several discharges, these discharges being yielded up by the dielectric of the condenser. So we see why accuracy in the measurement of the capacity of a condenser is difficult to attain, that much depends upon the length of contact maintained during charging;* for if we charge for two seconds much (*not* twice as much) more electricity will enter the condenser than if we charge for one second.

If we are dealing with electricity of high tension generated by a frictional machine, and are charging a Leyden jar by this means, even after discharge of the jar, a painful shock may result from contact with the two armatures, the shock being given by the residual discharge.

In future numbers we shall continue the investigation of the results of this absorption.

PAPERS FOR JUNIOR STUDENTS.

Laws of Electro-Magnetism.

We are about to enter upon some tedious detail. A little perseverance, however, will be rewarded by a clearer comprehension of the nature and effects of the electrical current, and by a facility of thought upon our subject. Where the law is a simple statement comment will be needless, but the student must not think that the law is unimportant because

* Presently we shall give an account of some apparatus devised for maintaining contact during a small fraction of a second.

we do not offer comment. We will commence with—

The Armature.—The attraction between an electro-magnet and its armature increases with the size of the armature.

In many electrical instruments, as in some ink-writers, the armature consists of a sheet of iron rolled in a cylindrical form, having this section—U. This form gives an armature of considerable size, at the same time light, and presenting but small opportunity—from the limited surface in contact—for the residual magnetism to cause it to stick upon the poles of the magnet.

The Wire.—When the current is of equal strength, the material and the thickness of the wire of an electro-magnet are without influence upon its magnetism.

The free magnetism is directly proportional* to the number of turns.

The attraction is proportional to the square of the number of turns.

When the currents are unequal, the magnet will attract a bar of soft iron with a force proportional to the square of the product of current strength and number of turns of the coil; or another, with a force proportional to the sum of the products of the current and number of turns on both magnets.

Polarity.—The south pole is always at the end where the current, from the carbon or copper of a battery, enters a right-handed helix.

Whatever be the nature of the helix, either right- or left-handed, if the end facing the observer has the current flowing in the direction of the hands of a watch, it is a south pole and *vice versâ*.

Effect of Strength of Current.—The free magnetism of the pole-faces of an electro-magnet is proportional to the strength of current passing in the coils; between two magnets the attraction is proportional to the square of the strength of the current.

Action of an Electro-Magnetic Coil on a Magnet.—A magnet (needle) in the axis of a circular current is attracted or repelled the centre with a force proportional to the superficial content of the circle. And the force with which a magnet is attracted by the coil is proportional to the product of the strength of the current and number of turns of the coil.

The Core.—The free magnetism, other things being equal, is proportional (1) to the square root of the diameter of the core, or (2) to the square root of its length.

These laws, although they may appear very formidable, really are very easy to understand, if we study them carefully. They may be passed over, however, if the student should prefer to follow the advice of Arago, "to go on, and return presently to what I could not comprehend." As we progress we shall see where the laws apply.

In our next study we shall turn to electro-magnetic instruments, telegraphic and general.

TELEGRAPHIC WIRES.—The *Times* states that the value of the telegraphic wire and apparatus belonging to it, exported in the last three months, amounted to £106,227, against £29,859 during the corresponding period of 1872.

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* For explanation of the terms "directly proportional," "varying inversely as the square" or "square root," &c., we refer the student to our papers entitled "MATHEMATICS FOR NON-MATHEMATICIANS," commencing in the next number.

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

An ordinary meeting was held on Wednesday, April 23, 1873. The chair was taken by Latimer Clark, Esq.

The CHAIRMAN announced that, in accordance with rule No. 5, which empowered the Council to elect, as honorary members of the Society, gentlemen who were eminent for their scientific services in connection with telegraphy, the Council had invited Sir George Airy and General Sabine to become honorary members. Letters acceding to the invitation had been received.

Two papers "*On the Block System of Working Railway Traffic*," were read to the meeting.

The first paper was by Mr. W. H. PREECE. The author was afraid that electricians would be disappointed at the character of the paper which he was about to read, and that those of the railway world would be affronted at the position which he took in assuming to himself the functions of a mentor. But, in fact, the railway system of this country is as yet far removed from the summit of the engineer's ambition—a perfect working machine, though it is certainly approaching that point. While the carefully prepared statistics of the Board of Trade show that the traffic is increasing with marvellous rapidity, the average number of total accidents is stationary. In the three years ending 1849, the average number of passengers killed by causes beyond their own control was 12, being (roughly) one in 4 million passenger journeys made. In the year 1871 the number killed was the same, while the proportion to the passenger journeys made was one in 31 millions. We have in these statistics the most powerful evidence of improved working, and of the beneficial effect of that process of scientific thought which is the application of the lessons taught by past experience to new and different circumstances. The reports of the inspecting officers of the Board of Trade upon the accidents which occur show exactly where the shoe pinches, and favour the application of the law of average in bringing out the defects or merits or variations in railway working.

Dangerous modes of working are frequently carried on for long periods without accident, but they invariably break down at last. One railway company may use an imperfect system for many years without accident, but if twelve different companies adopt the same system, the probability is that before many months elapse something will show a defect which requires to be cured. The published reports of the Board of Trade furnish experimental data from which a pure science of railway working can be formed. A careful examination of 138 accidents which were reported upon has enabled the author to summarise the causes of accidents into four heads. Those due to defective permanent way have formed 18 per cent; those due to defective rolling stock 13 per cent; those due to defective human machinery 41 per cent; those due to defective signalling arrangements 28 per cent. Of these accidents 56 per cent were the effect of collision always preventible.

Now, the question naturally arises, why should there be such a wide difference in the safety of trains travelling upon the southern lines as compared with the northern lines? Is it that the elements of accident are more abundant in the latter than in the former; that the traffic is more crowded; that there is a greater variation in the character of the trains; and that the speed is higher? Or is it that the systems are more lax, and that the accommodation is more defective? The author cannot answer these questions; but there is one fact strikingly evidenced on the southern lines as compared with the northern lines, namely, that upon the southern lines the block system is carried

out in its entirety to a greater extent than upon the northern lines. Of the 16,000 miles of railway in the United Kingdom, only about 4000 are worked upon the much-talked-of block system. Now, what is the block system? It is that system by which trains are kept apart, upon the same line or rails, by a certain and invariable interval of space, instead of by an uncertain and variable interval of time. The term "block" itself is a most unfortunate one. It was introduced in the early days, through the practice of blocking or pinning over the telegraph needle in the early instruments used to work this system. The "*space* system," in opposition to the "*time* system" would have been far more appropriate. The practice under the time system is to exhibit the danger signal for five minutes, and the caution signal for five minutes more, after a train or engine has passed any station, junction, level, crossing, or siding. Trains are thus kept apart by fixed periods of five minutes, and, if the caution signal were more properly regarded, they would be kept apart by an interval of time even longer than this. The speed of a train is entirely the responsibility of the driver. Immunity from accident is dependent upon his keeping a clear look out. If engines ran at regular and fixed speeds, if the driver could always ensure a good view before him, and if the signals were near together and were properly regarded, a rigid interval of time might be maintained between following trains. But none of these elements of safety are constant. Fast expresses follow slow goods trains, now through a thick fog, and then in bright sunshine. Trains are so frequent in some places that the interval cannot be adhered to; obstructions to view arise from curves and cuttings and atmospheric causes; long lengths of line are unprotected by signals, and signals themselves are frequently neglected. Hence the time system is brimful of elements of danger, and the inexorable logic of facts has shown that the time interval is illusory, and the system unsafe. When trains are invariably kept apart by an interval of one or two miles, collision between them becomes impossible. This is the block system. This system has, very improperly, been divided into two classes—the "absolute" block and the "permissive" block. The absolute block is the block system proper. The permissive block is not a block system at all, but a system introduced by the London and North Western Railway Company at the suggestion of Mr. Edwin Clark, not to secure the safety of their trains, but to increase the capacity of their line for the transmission of their enormous and increasing traffic. It is doubtless an improvement on the time system, but it bears little affinity to the block system, and should certainly not be included in the same category. There is a very broad distinction between the block system as an abstract principle and the means of carrying out that principle. We hear of Tyler's, of Walkers, of Spangaletti's, of the needle, and of other block systems. They are *not* block systems, but simply instruments devised to carry out the electrical portion of the block principle. The carrying out of the block system means an entire rearrangement of the rules and regulations of the working traffic, a complete re-organisation of the signals, the construction of fresh siding accommodation, the education of the staff, the transference of much responsibility from the drivers to the signalmen. Moreover, the working of the block system is not necessarily an electrical question. If the sections of the line be very short it can be worked by mechanical or by pneumatic agency, and where the sections are long and the trains are few it can be worked by a staff. On busy occasions, when the trains are numerous, it is quite possible to work the block by ocular agency, by merely planting men within sight of each other to regulate the trains by flags and other means. The time system having been proved to be inefficient, and the block system having been shown to be the safer principle, how is it that the adoption of the block system in this country has been so slow? People as a rule are very sceptical of any new invention until it has been practically established for a long period, and particularly so when it is based upon principles which are not understood. It took the public a very long time to get used to railways, and it took railway authorities a much longer time to get used to the telegraph. Even now the telegraph is looked upon as an expensive auxiliary, bringing in no returns; or, at least, this was the case before the transfer to the Government. The accidents it has prevented and the lives it has saved are unknown. It is the last thing thought of in the construction of a line: it is the very first thing flown to in moments of danger and difficulty. But its principles are not understood; and the application of electricity to signalling purposes is still less apprehended. On the London and South Western the first outlay in the construction of the block was £125 per mile. The annual cost of maintenance is £60 a mile. On the London, Chatham, and Dover the first cost was £174 a mile; the annual maintenance £60 a mile. On the Midland line the annual cost is between £30 and £40 a mile on the main line between London and Bedford, according to returns furnished to the Board of Trade, but this sum probably referred only to the electrical portion of the system. The South Western figures, probably, more nearly represent the total cost of maintenance. The electrical appliances form but a small item of the total cost of the block system, the expense being chiefly due to the signal boxes, interlocking apparatus, and other accessories. But in addition to the question of cost which has delayed its introduction, there is a certain amount of prejudice against its working. It is said to introduce delay, and to be objectionable, because it removes the responsibility from the driver to the signalman. Experience had shown that, under proper regulations, there is not only an absence of delay, but absolute expedition in working, with the block system, and that the capacity of a line for the conveyance of trains is largely increased thereby. And, as regards the responsibility of the driver, this had, if anything, been increased, for the correct working of the block depends essentially upon the driver paying proper regard to the signals. But, in addition to this, the block system has instilled into the driver an amount of confidence which he never felt before, and checked that daring recklessness that was at one time so prevalent. Thus prejudice, cost, and indifference, have led to the neglect of the block system. These objections are, however, rapidly dying out, and most of our great railway companies are now largely extending the block. In the external visual signals uniformity should be secured. The author is far from advocating the block system as the cure for every evil. We know well that where we are dependent upon human agency mistakes will arise; and various defects in connection with the permanent way and rolling stock might be a cause of accident. But the author contends that a compulsory block system would cause other improvements to follow in its wake.

The second paper, on the same subject, was read by Major MALLOCK. The author was lately ordered by the Government of India to report on the use of the telegraph in connection with railways in England, and the paper contained some of the results which he had arrived at in pursuance of that order. The block system, as used in England, is chiefly applied to double lines, and may be distinguished by the general name of the non-following block, in contradistinction to the non-meeting block which is necessary on single lines. There are various methods of carrying out the block system, any one of which, looked at by itself, is

apparently perfect, but to choose between them it is necessary to know what is really required. No rules on the subject have been issued by the Board of Trade. There are seven main classes of instruments now used with the block system. There are also variations of them, but these all depend on the main classes. There is, first, a double needle instrument, combining a bell, introduced by Mr. Edwin Clark on the London and North Western Railway, in 1854; second, electro-magnetic semaphores combined with bells, introduced by Mr. Preece in 1862; third, variations of Clark's needles and bells, introduced by Spangcletti in 1862; fourth, the working of bells alone, introduced by Walker on the South Western Railway in 1861; fifth, an electro-magnetic semaphore combined with bells, introduced by Mr. Walker in 1866: sixth, two indices combined with a bell, introduced by Tyer in 1869; and seventh, a modification, introduced in 1872, of Preece's original instrument of 1866. The first three of these instruments are usually called three-wire systems, and are worked by a permanent current. They require one wire for each line of rails, *plus* one wire for the bell. The last four are called one-wire systems, and are worked by a temporary current. A needle instrument of any sort permits of talking, and is otherwise dangerous. At first sight needle instruments seem so cheap, and so easy to understand and repair, that a person not acquainted with the subject would be apt to prefer them, but there are in connection with them certain imperfections and dangers. The theory of working them is, that a constant positive current kept on the line by the commutator being pinned over will show the line blocked, whilst a negative current shows the line clear, or *vice versâ*. In actual practice, however, line clear is only signalled on the train arriving, and then the needle is allowed to fall to zero, the re-result being that should the needle be pinned over, and the line blocked, the needle will fall to zero. The theory is that a man ought not to consider the line clear unless he has had a call on the bell, or the needle be put over to line clear until he has answered. It will be readily seen how easy it is in practice, when a man is hurried, for him to make a mistake. The Board of Trade inspectors have expressed their opinion that a talking instrument is most necessary, but still it is only as an adjunct to the block system. A flash of lightning may reverse the magnetism of the needle instrument so that it will show "line clear" when it is meant that the line is blocked. Of the one-wire system there is no use in contemplating. Walker's bell without indices, when the introduction of the latter is a great safeguard and not much expense. In Tyer's instruments the workmanship is exceedingly good, and they are apparently the most sensitive instruments, and calculated to work the longest distances, but, like needle instruments, they are liable to have reverse signals given on them by atmospheric electricity. Also the plungers, which give the signals "Line clear" and "Train on line," are so much alike that they may be mistaken by a man in a hurry. Walker's instrument is strong, but possesses somewhat similar disadvantages. In Preece's instrument (worked by a single wire) the commutator which charges the signals "Train on line" and "Line clear" is a miniature semaphore lever, and therefore there is much less chance of mistake than with the other instruments. It also admits of interlocking, like Varley's system. In consequence of a recent addition, the signal "Line clear" cannot be given unless both sender and receiver are concerned in making it, and therefore atmospheric currents will cause no mistake. The single-wire systems are generally used for the non-following block; but where there is a single line of railway, and the non-meeting block is used, the rule is that no second train goes into the same section in either direction. In India, however, they got into a complication with single lines which is not contemplated by either of these systems, namely, that the line being blocked ahead with trains going up, any number may go down it. That is the permissive block system. If absolute block is to be introduced in India, either this plan must be prohibited, or they must provide for a non-following block *plus* a non-meeting block. The author proposes to do this by two wires:—

$$A\left\{\begin{matrix}-B-C-D-\\ \\ \end{matrix}\right\}E$$

Looking upon A and E as two sidings, and B, C, D as cabins between them, the lower line of the diagram would be a non-meeting block, whilst the lines between the cabins would be a non-following block. The manager of the South Western Railway has said that such a system combined with a train register would be perfect. The paper then gave some particulars of a conference of railway managers and others, held at Berlin on the 1st of December, 1870, with reference to the block system, and detailed a series of principles which were adopted at that conference. The author concluded with a series of twenty-four rules which he had deduced from his investigations as to the working of the block system in England, and which coincided with the spirit of the principles laid down by the German Conference, but were somewhat more comprehensive. The rules so laid down by the author consisted of a series of affirmations to the following effect:—The block system entails no loss of time, but, on the contrary, enables a far greater traffic to be carried on. It is essential to the safe working of a line. The system of the "permissive" block is most dangerous. It is of no use to establish a block system if the sections are too short for a train going at full speed to stop in, or if a slack method of working be permitted. Any station at which shunting is or may be carried on must be guarded by the block. A private code of signals between the men must not be allowed. Whatever system of block is introduced, a train register is wanted. On dangerous sections a train should report back its own arrival. Besides block instruments, talking instruments should be provided, and these must not be interposed in circuit with others, but each section must work separately. On exceptional sections the block instruments should interlock with the semaphore levers. "Line clear" should not be signalled back until the tail-board of a train is seen, lest any of the carriages should be left on the line. The line staff has proved inoperative without the assistance of the telegraph. Electric repeaters are required. The block system is as necessary with light as with heavy traffic. Where a bell-code is in use, a large number of beats is liable to lead to confusion. Needle instruments which can be used for talking are objectionable as block instruments. It should be impossible to show "Line clear" unless the signalmen at both ends are concerned in making the signal. Plungers, such as those of Tyer and Walker, which may be mistaken in the hurry of working, are dangerous. At the junction of two lines the block instrument should interlock on the principle of Saxby and Farmer's interlocking semaphore levers, so that "Line clear cannot be telegraphed to both sections at the same time. Exceedingly simple instruments are desirable. The working of the block instrument should approximate as much as possible to the working of the the outside semaphore. A single-wire system, working with a temporary current, cannot be considered perfect if lightning can reverse the current or demagnetise the instrument. The receiver must not be able to alter the index of incoming signals at his station.

After the reading of the papers, Mr. W. H. PREECE described a collection of electrical signalling instruments, which had been devised from time to time for use in connection with railway traffic.

Mr. Carr, the inventor of one of the instruments which were exhibited, explained the working of his invention. He said that the chief object of this appliance was to do away entirely with the necessity for the signalmen, by giving the signals directly on the engine. An indicator furnished with movable discs exhibited the signal "Go on" or "Stop," according to the state of the line, and the electric current necessary for determining the signal depended upon the position of the train preceding that upon which the signal was received. It was another great advantage of this invention that the communicating wire could be carried through any points or crossings connected with the main line, so that as long as the points were open the signal "Stop" would be given, and directly the points were closed the signal "Go on" would be shown. The arrangement was entirely electrical.

The Chairman said that it would be necessary to adjourn the discussion to the next meeting, but it might be commenced now for the accommodation of those who could not attend at the next meeting.

Mr. Malcolm, of the Board of Trade, said, in allusion to a statement contained in the first paper, that, as a matter of fact, the Board of Trade had no legal power to require the block system to be set up on the opening of a new line. They, however, required that the points and signals should be in every case interlocked whenever there was an opening on to a main line.

Mr. Barlow said that he would refer to one part of the paper of Mr. Preece, which seemed to imply that the endeavours after the safety of a railway was due to the inspection of the Board of Trade. Nobody could appreciate more than himself the talents of the Board of Trade inspectors, and he believed that they had done a great deal to assist in improving the safety of railways. But railway companies had another very urgent cause operating upon them, and that was the Compensation Act of Lord Campbell.

Mr. Leeman, M.P., said that he had come to listen, and to gather information, rather than to impart anything to the meeting. Practically, he knew nothing about the working of electrical apparatus, but there were one or two remarks which were contained in the first paper as to which he should like to say a few words. One was that the author feared that, as far as the directors of railways were concerned, there was no disposition to adopt the block system, seeing the large expense in which it would involve their companies. As Vice-Chairman of a railway of some 1400 miles in length, he (the speaker) was bound to say that he did not think that that was a remark which applied to railways generally, and that, as regarded the particular company which he represented, there was no amount of expenditure which was necessary to secure the public safety which the directors were not prepared to incur. He believed that the managers of railways would hesitate to endorse the statement that they from time to time made suggestions to their directors which the directors were not prepared to adopt. He was certain that it was not so with regard to his own company. With one or two exceptions, the evidence of the practical managers of the large railways was that, while they believed that the block system might do a very great deal for the promotion of public safety, yet if an accident happened under the block system the evil consequences might be far greater than those which would arise under the other system. The committee therefore came to the conclusion that it was not desirable to enforce this block system upon the railway companies until there had been further experience of its working; and surely if anything could have justified that report, it was the extent of danger which might exist under any system of block, as shown by the two papers of this evening. According to the last paper there were twenty-four different rules which were to be adopted if the system was to be rightly applied. Was not the very fact that it was necessary to bring the men into coincidence with twenty-four rules, before the block system would ensure safety, the very best explanation of the fact stated by Mr. Preece —that 28 per cent of the accidents which took place were due to the imperfection of the human agency? He (Mr. Leeman) was afraid that their friend Mr. Preece had never worked a railway in his life. If he had not, he (Mr. Leeman) might tell him that until he could ensure perfect human infallibility (and that was not possible) there would be accidents, under either the block system or any other. While he had the greatest possible respect for those who worked the telegraphs, he hoped that the telegraphic engineers of this country would not allow themselves to be run away with by the reasoning of the gentlemen who had read the papers, and think that they could entirely prevent accidents on railways under the block system, and so be led to seek to force that system on the railway companies.

Major Mallock, exhibiting a thick bundle of papers, said that it was composed of lists of the accidents which had occurred either where there was no block or where the block was only permissive; and these lists bore out the different rules which he had given, which might more properly be called axioms to be observed in preparing a system. This certainly proved that accidents had occurred for want of the block system.

Mr. Leeman.—I beg the gentleman's pardon. It proves that accidents have occurred, but that it proves that they occurred for want of the block system I utterly deny.

The discussion was then adjourned to the next meeting.

ROYAL SOCIETY.

A paper "*On the Decomposition of Carbonic Oxide*," was read (April 3) by Sir B. C. Brodie, Bart., D.C.L., F.R.S. In connection with the investigation on the electric decomposition of carbonic acid gas referred to in a previous communication to the Society, I was led to submit a mixture of hydrogen and carbonic oxide gas to the action of electricity in the induction tube, the mixed gases being circulated through the tube by means of an apparatus which I will not now describe. A contraction was soon observed to have taken place, which at the end of an hour amounted to 10 c.c. The rate of contraction steadily diminished, and during the fifth hour of the duration of the experiment amounted to only 2 c.c.

In a similar experiment made with a mixture of hydrogen and carbonic acid gas, a contraction also occurred, attended with the formation of water. The gas which resulted from the experiment was found to consist (after the absorption of carbonic acid) of hydrogen and carbonic oxide, together with a little marsh-gas. Traces of oxygen and nitrogen were also present. Minute drops, too, of an oily liquid appeared in the tube. This liquid, after the conclusion of the experiment, was dissolved in a small quantity of water. The solution was strongly acid and had a pungent taste. It reduced an alkaline solution of terchloride of gold and an ammoniacal solution of nitrate of silver. These reactions are the characteristic properties of formic acid, of which we may infer the synthesis to have been effected according to the equation—

$$H_2 + CO_2 = H_2CO_2.$$

I may avail myself of the present opportunity to place on record the following important facts in reference to the action of electricity on carbonic oxide gas.

When pure and dry carbonic oxide is circulated through the induction-tube, and there is submitted to the action of electricity, a decomposition of the gas

occurs, attended with a gradual and regular contraction, which in the form assumed in my experiments, occurred at the regular rate of about 5 c.c. in an hour. Carbonic acid is formed, and simultaneously with its formation a solid deposit may be observed in the induction-tube. This deposit appears as a transparent film of a red-brown colour, lining the walls of the tube. It is perfectly soluble in water, which is strongly coloured by it. The solution has an intensely acid reaction.

The solid deposit in the tube, in the dry condition before it has been in contact with water, is an oxide of carbon. Samples, however, made in different experiments do not present precisely the same composition; but nevertheless they appear to belong to a certain limited number of forms which repeatedly occur, and may invariably be referred to the same general order or system.

A paper "*On an Air Battery*," by J. H. GLADSTONE, Ph.D., F.R.S., and ALFRED TRIBE, F.C.S., was also read. The galvanic battery which we are about to describe is founded on a reaction that we brought under the notice of the Royal Society last spring.* We then showed that if pieces of copper and silver in contact are immersed in a solution of nitrate of copper in the presence of oxygen, a decomposition of the salt ensues, with the formation of cuprous oxide on the silver and a corresponding solution of the copper, while a galvanic current passes through the liquid from copper to silver. We stated, moreover, that this was no isolated phenomenon, but only one of a large class of similar reactions. It seemed desirable to examine more fully the history and the capabilities of the electrical power thus produced.

It was previously ascertained that the combination of the oxygen takes place only in the neighbourhood of the silver; and the following formulæ may serve to render the chemical change and transference more intelligible:—

Before contact—

$$m\mathrm{Ag} + \mathrm{O} + \mathrm{Cu_2NO_3} + \mathrm{Cu_2NO_3} + n\mathrm{Cu};$$

after contact—

$$m\mathrm{Ag} + \mathrm{Cu_2O} + \mathrm{Cu_2NO_3} + \mathrm{Cu_2NO_3} + (n-2)\mathrm{Cu}.$$

This action is evidently a continuous one until either the oxygen or the copper fails.

Now the oxygen of the atmosphere is practically unlimited in amount, but there is a difficulty in bringing any large quantity of it into contact at once with the silver and the dissolved salt.

To facilitate this, we arrange that the silver plate should have a horizontal position just under the surface of the liquid in the cell; and, in fact, we convert it into a small silver tray full of crystals of the same metal, which rise in projections to the very surface. The copper plate lies horizontally under it, separated, if need be, by a piece of muslin, and connection is made by a wire as usual. The vertical part of the copper plate, from a little above the liquid to the bend, should be varnished; otherwise solution principally takes place there, which causes the horizontal part of the plate to drop off. Holes are made in the silver tray with the view of shortening the communication between the air-surface and the copper plate, and of facilitating the movements of the salt in solution. The solution itself may be contained in a shallow trough or saucer.

That dissolved oxygen is absolutely necessary for this chemical change has been already shown; but it was interesting to measure by a galvanometer the difference of the currents obtained by means of an ordinary, that is aërated, solution of copper nitrate, and one from which the air had been separated to the greatest possible extent. A Thomson's galvanometer was employed, which had a resistance of 2631·5 units at 18·3° C. Two cells were prepared with vertical plates and alike in all respects, except that the one contained an ordinary 6 per cent solution of copper nitrate, and the other a similar solution which had been deoxygenised by the means described in our former paper. Another experiment was made with a different pair of cells and an 11 per cent solution. It was necessary to use the 1-99 shunt; and the following were the amounts of deflection:—

Time after immersion.	Expt. I.		Expt. II.	
	Oxygenised.	Deoxygenised.	Oxygenised.	Deoxygenised.
1 minute.	78	14	130	11
4 minutes.	72	9	90	8
12 ,,	68	6	75	6
49 ,,	—	—	58	3·5

The contrast is evident. That the deoxygenised solution does give a deflection at all is due partly to the difficulty of excluding air, and partly, perhaps, at first to the oxygen condensed on the surface of the silver plate. The effect due to the water itself is inappreciable.

From the nature of the reaction it might be expected that the current would gradually diminish on account of the using up of the dissolved oxygen in the neighbourhood of the silver; such a diminution always does take place, at least after the first few vibrations of the needle.

It might be expected, too, that when the amount of action has run down considerably, the mere moving of the liquid so as to bring fresh parts of the solution against the silver would augment the currents. It does so.

The same might be predicted from stirring up the crystals of silver in the tray so as to expose new surfaces. This also was found to be the case.

And, again, it might be anticipated that if the wire were disconnected for a time so as to allow the oxygen to diffuse itself from other parts of the solution, and the connection were made, the current would be found as strong, or nearly so, as before. That also is true in fact.

A cell with the plates connected by a wire was placed under a bell-jar full of air over mercury. The mercury gradually rose inside, as might be expected from the absorption of the oxygen in the air.

The necessity of oxygen and the avidity with which it is taken up are both illustrated by the following experiment:—Two cells with horizontal plates were prepared alike in every respect, except that the first was filled with a solution simply deprived of oxygen, the second with a solution through which a stream of carbonic acid gas had been passed for some time. The first was placed in the air, the second in a vessel from which the air had been expelled by allowing carbonic acid gas to flow into it for an hour or two.

The deflections obtained were as follows, the 1-999 shunt being used and the temperature being 13·7° C.:—

Time after immersion.	In air.	In CO_2.
1 minute.	165	76
5 minutes.	135	62
10 ,,	135	58

As the cell in an atmosphere of carbonic acid gas showed considerable action, in fact nearly half as much as that in the air, each cell was short circuited for twenty-three hours, with the expectation that any oxygen in the closed vessel would be used up; and, indeed, the most prominent crystals of silver in the cell in carbonic acid gas became reddened, while a cuprous deposit extended over the whole of the crystals in the other cell. When, however, the short wires were removed and the galvanometer interposed, the cell in the air gave a deflection of 136, practically the same as before, but that in carbonic acid gas, instead of showing a great decrease, rose to 80. It was then found that the vessel containing the latter slowly admitted air; so that the contents were swept

* 'Proc. Roy. Soc.," April, 1872, vol. xx., p. 290.

out by a fresh stream of carbonic acid gas, and it was made properly air-tight. After connection by a short wire for three days the galvanometer indicated a deflection of 20, that of the cell in the air being 110, temperature 10° C. As this showed a very great reduction of the chemical action, carbonic acid gas was again passed through the vessel for an hour or two; and after a connection of two more days the indication of the galvanometer was only 3, while the other cell gave 115, the temperature being now 10·5° C. The action, therefore, was at last reduced almost to nothing; and the original fault in the experiment brought out, perhaps more clearly than would otherwise be seen, how eagerly the solution will absorb even minute quantities of oxygen from the surrounding gas.

An important point to determine was the best strength of the copper nitrate solution. Six per cent was generally preferred, for two reasons:—first, it gives about the maximum of effect—a solution four times as strong gives less than half the deflection, and a solution only a quarter as strong gives only two-thirds; secondly, a stronger solution than 6 per cent is apt to produce a deposit, not of pure cuprous oxide, but of a subnitrate, which was supposed to clog up the silver crystals to a greater extent.

Another point investigated was the best proportion between the areas of the metallic surfaces. Experiments were made with vertical plates, in which the silver was kept at a uniform size, and the copper was diminished by covering it more and more with varnish; and another set was made in which the copper remained the same, while the silver plate was reduced.

The results may be thus exhibited:—

Proportion of surfaces.		Deflection.		
Silver.	Copper.	Expt. I.	Expt. II.	Expt. III.
1	0·25	24	23	—
1	0·50	28	27	—
1	0·75	31	30	—
1	1·00	33	32	28
1	1·33	—	—	28
1	2·00	—	—	32
1	4·00	—	—	30

The increase of the copper surface, therefore, has comparatively little effect.

Proportion of surfaces.		Deflection.		
Copper.	Silver.	Expt. I.	Expt. II.	Expt. III.
1	0·25	—	—	7·5
1	0·50	—	—	16
1	0·75	—	—	21
1	1·00	33	32	28
1	1·33	41	40	—
1	2·00	56	54	—
1	4·00	96	92	—

The increase, therefore, of the silver or negative metal causes an almost proportionate increase in the chemical action. This, doubtless, arises from the necessity of oxygen, and explains the value of the large surface exposed by the silver crystals in the tray.

The effect of heat on the action of this cell was examined; it increases the action greatly: thus an arrangement, which gave a deflection of 40 at 20° C. gave one of 250 at 50° C.; and the augmentation was observed to be much more rapid in the higher than in the lower portions of this range of temperature.

If the formula given above for the reaction be a true one, it follows that every atom of copper deposited on the silver in the state of suboxide must be compensated by an atom of copper dissolved from the copper plate. This was proved quantitatively. In a cell that had been in action for a week the loss of the copper plate was 0·391 grm., while the suboxide deposited on the silver was found to be equivalent to 0·398 grm. of metallic copper. This deposit of suboxide, though it soon forms apparently a complete covering to the silver, does not greatly diminish the action; it is probably porous, besides being itself a conductor of electricity. In some case we have found it deposited in crystals sufficiently large to be seen by the naked eye, and which are shown by a magnifying glass to be regular octahedra.

The internal resistance of this battery, as might be expected, is small.

The electrolytic power of the current was examined. One cell, the plates of which were about 2 inches in diameter, was found sufficient to decompose such metallic salts as the nitrates of copper, silver, or lead, copper sulphate or stannous chloride, in aqueous solution, when platinum was used for the negative electrode, and for the positive the same metal as existed in the salt experimented on. Six cells were sufficient to decompose dilute sulphuric acid slowly and dilute hydrochloric acid pretty quickly, copper electrodes being employed.

The theoretical interest of this battery lies mainly in the fact that it differs essentially from every other galvanic arrangement, inasmuch as the binary compound in solution is incapable of being decomposed either by the positive metal alone or by the two metals in conjunction; it cannot serve, in fact, as the liquid element of the circuit without the presence of another body ready to combine with one of its constituents when set free.

Grove's gas battery is essentially different from ours if the oxygen and hydrogen condensed on the platinum plates play the part of the two metals; but it closely resembles ours if hydrogen acts the part of the positive and platinum that of the negative metal; the dilute sulphuric acid, a hydrogen compound, will then be decomposed on account of the simultaneous presence of the oxygen, which can combine with the liberated hydrogen. Viewed in this manner, Grove's gas-battery is only a special case of the general reaction which we have described in a previous paper; and the formula will be:—Before contact, $m\mathrm{Pt}+\mathrm{O}+\mathrm{H_2SO_4}+n\mathrm{H}$; after contact, $m\mathrm{Pt}+\mathrm{H_2O}+\mathrm{H_2SO_4}+(n-2)\mathrm{H}$.

The practical interest of our arrangement lies in the fact that it is an approximation towards a constant air-battery. Should it ever come into use elsewhere than on the lecture table, it will probably be in the form of a combination of zinc and copper, with an aërated solution of zinc chloride; for that arrangement has an electromotive force six times that of the arrangement we have more particularly studied, and about three-quarters that of a Daniell's cell. The numbers representing the difference of potential between the two metals, which were actually obtained by means of an electrometer belonging to Sir William Thomson, were—

Silver and copper with deoxygenised copper nitrate	4
Ditto ditto oxygenised ditto	8 to 11
Copper and zinc with chloride of zinc ..	62
Ditto ditto water	68
Ditto ditto Daniell's cell	83

Chloride of zinc is preferred to the sulphate, as it offers less internal resistance, and a solution of 20 per cent is recommended as about the best conductor. A single cell of this description is capable of decomposing dilute sulphuric or hydrochloric acid, when copper electrodes are employed. The two metals might be arranged as in a Daniell's battery; the zinc would of course require no amalgamation, and the whole might be left for weeks or months without any attention. The oxide of zinc produced generally falls to the bottom of the vessel, and may be separated whenever it is thought desirable.

The power is thus obtained at a minimum of expense, for the oxygen which combines with the zinc costs nothing. Such a battery would appear to be specially

adapted to cases where the galvanic current has to be frequently broken, as in telegraphy; for at each period of rest it renews its strength by the absorption or diffusion of more oxygen from the air.

Electrical Science in Foreign Journals.

(We intend to devote this column to a list of Electrical Memoirs published in Foreign Journals during the month. Those of importance will be either translated in full or given in abstract.)

The Telegrapher. April 5, 1873.

On Economical Line Construction.—By David Brooks. —The number of posts per mile usually employed in this country is double the number used in Europe. The greatest number per mile in England is twenty for ten or more wires. On the Continent it is rarely over sixteen, yet their lines are very substantially built. It has been objected to this system of reduced number of poles that the wires are more liable to be broken by sleet, but that does not follow. A No. 8 or 9 wire of good quality will sustain the necessary tension, say 350 to 450 lbs., and an additional strain of 1000 lbs. without breaking, and that is far greater than any sleet will produce; but if fifty poles to the mile are used with wires pulled tight, sleet will break every span. With sixty poles to the mile, to avoid this very difficulty over the Alleghenies, I have seen the wires entirely prostrated by sleet, owing to the wires being stretched too tight. It has been urged, also, that the wires are more liable to be crossed and twisted by high winds, but with a secure fastening for the wire at the insulators that does not follow. The weight of the wires keep them at their proper distance apart, and when moved by the wind, "swing and keep time together." In 1867 I spent two weeks travelling with one of the *Inspecteurs* through France, where they were rebuilding their lines and reducing the number of poles. The portion of the French lines along the British Channel are exposed to very violent winds. The wires run over the bluffs, which rise hundreds of feet perpendicularly from the sea, and these shores are subject to very violent gales; in winter they are also subject to sleet, yet I venture to say there are no lines in this country that will stand the exposure that theirs do. About twelve years since there was inaugurated in Europe the use of large size wires for the long circuits—wires of 4 and 5 millimetres in diameter, equal to our No. 4 and 3 gauges, but no material improvement was effected until the lines were reinsulated with what is known as the Prussian Insulator. About the year 1863 and 1864—say ten years since—this insulator was adopted in Russia, Sweden, Denmark, Italy, and in France in 1867. The effect was to enable them to work from four to five times as far in bad weather as with the earlier kinds, which were generally glass, as good or better than the modern glass of this country; or, in other words, they could work a No. 11 or 12 wire a much greater distance than formerly a No. 3 or 4. The economy of this change of insulation in the construction of lines is at once manifest. Now the wires erected are no larger than No. 8 for the long circuits, besides the length of the circuits worked are longer than formerly. The longest line without repeaters, or in single circuit, is from St. Petersburg to the East Indies, over 3000 miles, and this with a No. 8 wire. The Prussian insulator has about four times the insulating properties of the common glass of this country; with half the number per mile they are enabled to work eight times as far in rain, which will carry them out of and beyond the storm, which seldom ever extends 500 miles in a direct line at the same time. Now the size most employed in the erection of new lines corresponds to our Nos. 11 and 12. Were I to build a new line of 200 miles, I should use no larger size than No. 11 galvanised steel or homogeneous iron. It costs about a cent more per pound than ordinary galvanised wire. The difference in cost of wire at present prices would be about 15 dols. per mile—say twenty posts per mile—and you have an additional saving of labour and material equal to 35 dols. per mile, or a total saving in cost of construction of 50 dols. per mile over a line built with No. 8 wire, and the usual number of poles per mile with glass insulators. Large and heavy conducting wires involve an expense that brings no adequate return. We must have conductivity, but a wire of No. 11 gauge can be worked 200 miles to the full capacity of the Morse system, and no more can be done if the wire were an inch in diameter. The larger wire requires less battery, but the saving of that expense has no proportion to increased expense of the heavy wire. There are other inconveniences, such as expense of transportation, difficulty in splicing, strain upon poles, &c., attending the use of heavy conductors, too obvious to need further reference. We will suppose an instance of 100 miles of line working twenty-five relays in the circuit, the relays having a resistance of 150 units each. The total resistance of the relays would be 3750, to which add the resistance of a No. 8 wire, 1500 units—total resistance of circuit 5250. In place of a No. 8 wire substitute a No. 11, having a resistance of 3000 units. Resistance of circuit in latter case, 6750; increase, 1500 units—about 22 per cent. To compensate for this loss in strength of current it would be necessary to add 22 per cent of battery, or a fraction over one-fifth the number of cells. The increase of battery will compensate a reduction in cost of wire amounting in round numbers to about 1500 dols. Three years since one of our railroad companies re-insulated a wire 250 miles in length. This wire was a plain No. 10, and had been in use twenty years. With the common glass insulators it had become little better than useless in rain. Since re-insulated it has been worked in rain without the slightest inconvenience or difficulty. Portions of this wire, measured by myself three years since, showed a resistance of over 60 units per mile. I recommended re-jointing and soldering of the splices. It has been worked since in all weathers, without that expense, up to the full capacity of any wire in dry weather. To have renewed the wire with No. 8 galvanised would have involved an additional expense of at least 10,000 dols. The report is, that this old wire works better to-day than a new No. 6 galvanised wire, upon glass insulators, running upon the same route. With splices re-jointed there is no reason why this old plain No. 10 wire should not do good service for years to come. How many hundred miles of wire have been thrown away, and thousands of dollars expended to replace the same with new wire, when the trouble was simply defective insulation. There are, of course, localities where wire soon becomes coated with rust and too brittle to bear splicing. Such portions must be replaced with new. Away from smoke and the gases of combustion, even a plain wire will last a long time. An article in one of the leading London scientific journals upon the bad condition of the telegraph service in the British East Indies, states that "there is no place in the world where there is such a lack of scientific knowledge in connection with the telegraph service, except America, as in the British East Indies. Whatever justice there may be in the remark applies to the structure of our lines. In this respect I do not think we are a whit behind the English. They stick to their old notions with a pertinacity that is perfectly inexplicable. The application of science to the arts or industries is to but one purpose, viz., to get the greatest return for a given amount expended. In

England their lines cost more and produce less than the poorest lines in this country, from the simple reason that their insulation is inferior to our common glass insulators. They fall no lower in hard rain, but they are very low in moderately damp weather—a kind of weather of which they have an abundance in England. Ten minutes of moderate rain brings their insulators down as far as they will get—a point to which glass insulators will not reach except when the rain is heavy. They are still using large and expensive wires to overcome their defective insulation. As soon as you cross the Channel a different state of affairs is at once manifest. Early in the history of the telegraph the French Government organised the department of "*Inspecteurs*," and none could enter this branch of the service without passing an examination in such of the arts and sciences as were considered necessary to qualify them for this particular vocation. Those entering this department were advanced and promoted according to the progress made in their profession. As a consequence, the works upon the telegraph written by the *Inspecteurs* are the best ever published, and splendid contributions to science. The very opposite course has been pursued by the telegraph companies in this country. When an employé manifests a desire to acquire a knowledge of the business as a science, or beyond that of a mere operator, he is hustled out of the way, from fear that his better knowledge may interfere with their own crude and ignorant notions. The cost of transmission of a despatch from one extremity to the other of France is a franc. To send one an equal distance in this country costs, instead of 20 cents, nearer 2 dollars, and the chances of its being incorrectly transmitted or delayed are in equal greater proportion.

Test of Insulators.—We are indebted to Mr. David Brooks for the following tests of insulators, made at his works in Philadelphia during the past five years:—March 1, 1868, there were exposed for galvanometrical measurement ten Prussian insulators of best Berlin standard. Ten large size Varley's double inverts with ebonite covered supports. Ten Western Union glass insulators, on brackets painted red. Ten Brooks insulators for cross-arms, taken from a lot then being made for the Central Pacific Railroad. During the intervening period of five years to March 1, 1873, there were ninety-three recorded tests in rain of these different insulators, averaging as follows:—For the Prussian, a resistance of 28 and $\frac{3}{10}$th millions units per insulator. For Varley's double inverts (English), 8 and $\frac{3}{10}$th millions units per insulator. For the Western Union, 8 and $\frac{3}{10}$th millions units per insulator. For the Brooks there have been but eleven rains in which they have fallen below 10,000 millions units per insulator, and the lowest was on January 15, 1873, when they stood at 2300 millions. The lowest point to which the Western Union have fallen was on January 3, 1873, to 2·6 millions. The lowest point to which the Prussian have fallen was January 17, 1873, to 19 millions. The lowest point to which the English have fallen was February 16, 1873, to three millions per insulator. The following results were obtained with some of the later styles of glass insulators:—March 1, 1872, there were exposed—Ten Boston screw glass, "cutting its own thread." Ten Chester's Patent, "three pointed contacts." Ten Western Union new style tie wire, near top of insulator. There have been twenty-one recorded measures in rain of these three varieties during the past year, the average of which is as follows:—For the Boston, 14·6 millions units per insulator. For the Western Union, new style, 24 millions units per insulator. For Chester's Patent, 71 millions units per insulator. The lowest resistance for the Boston was on January 3rd, this year, 6·4 millions units per insulator. For the Western Union new style, same date, 3·5 millions. For Chesters, October 26, 1872, 11 millions. As compared with Western Union old style, for the first year's exposure, the new style and Boston are both below, but Chester's is above, or something of an improvement. The new style of Western Union glass has the groove for tie wire placed near the top of the insulator, upon the principle of giving the outside insulating surface greater length. The old style has the tie wire placed about 1½ inches from the bottom of the glass, while the new is 3 inches above. Five of the new glass were measured in eight rains, with a small copper wire wound round 1½ inches above the bottom, and compared with five with the tie wire properly placed in the groove, to determine the advantage gained by this one and a half additional length of outside surface. The five insulators with the tie wire in the groove gave an average greater resistance, in the proportion of 60 to 59—not quite 2 per cent.

On a Method of Determining the Actual Resistance of Old Telegraph Line Wires.—It has long been known that the resistance of telegraph line wires increases after they have long been in use, owing principally to the reduced section of the wire arising from oxidisation and imperfect joints. It is not proposed in this article to discuss the various causes which modify the resistance of iron wires, but to give a simple formula, by means of which the true value of the resistance may be determined, and consequently the relative value at any given time. Taking, for example, a wire which has been in use for a period of ten or twelve years. If we measure its apparent resistance by any of the ordinary methods, the distant end of the wire being to ground, we shall obtain a result which represents, not the actual resistance of the conductor, but the total resistance opposed to the current, viz., the joint resistance of the conductor and of the insulators. Now, it must not be forgotten that the resistance of the insulators decreases by long exposure, while at the same time the resistance of the conductor increases. It is true that in very dry weather, and with good insulators, the losses by escape on a new line are null, or at least so small that they may be neglected without appreciable error. This is far from being the case, however, even in good weather, upon a line that has been long in use, and the losses from this cause cannot be neglected when it is necessary to ascertain the actual value of the increased resistance of the line. If this source of error be not taken into account—as is too often the case—we shall not arrive at a correct knowledge of the actual condition of the wire, for faults in the insulation may be concealed by faults in the conductivity, and *vice versa*. To obtain a correct result we may proceed in the following manner:—Suppose a line, A B, which is defective in point of conductivity, but in an ordinary condition in respect to insulation—that is to say, without any special insulative fault—measure the *apparent* resistance of the line from the point A, the distant end, B, being grounded or put to earth. Call the result of this measurement R_ℓ. Now the line is subject to leakage along its entire length, there being a slight loss at every insulator, which latter, for all practical purposes, may be considered uniform and equal. We may consider the sum of these leaks as a single leak, located at the middle point of the line, C, and we will designate its resistance as y. Therefore, the resistance R_ℓ actually represents the resistance of half the line, viz., A C, plus the joint resistance of the other half of the line C B, and the derived circuit or leak, y, at C. If we let x stand for the true resistance of the line C D, we have the following equation:—

$$R_\ell = \frac{x}{2} + \frac{\frac{xy}{2}}{\frac{x}{2} + y}$$

If, now, we again measure the resistance from the point A with the line open at B, all the current passes through the derived circuit, y, at C, and we obtain a second value, R_0, which represents the resistance of the derived circuit, y, plus half the line, viz., that between A and C, therefore—

$$R_0 = y + \frac{x}{2}$$

from which we deduce the value of y—

$$y = R_0 - \frac{x}{2}$$

R_ℓ and R_0 having been determined by the tests, the value of x is readily obtained—

$$x = \frac{4R_0}{2} - \sqrt{\frac{16R_0^2}{4} - 4R_\ell R_0}$$

Thus, for example, if $R_\ell = 833{\cdot}33$ units and $R_0 = 1500$, the value of x would be 1000 units. Similarly from equation (3) we can, by the substitution of the known value of x, get the true value of the insulation resistance between A and B.

Journal Telegraphique. Vol. ii., No. 15.

Multiple Transmission by the Same Wire.—By M. Mayer.—We give a full abstract elsewhere.

On Differential Galvanometers.—By Louis Schwendler.—A translation from the English.

Simultaneous Transmission.—[M. Wenckebach, an old telegraph engineer, has made the following communication to the *Journal Telegraphique* as a resolution of the problem of simultaneous transmission. As the solution indicated by the author is entirely theoretical, and has not been confirmed by experiment, the paper is published as an idea susceptible of enlargement.]—Many have sought more simple means of double transmission. I have also sought this solution, but by an entirely different process. It is a generally known fact that frictional electricity is propagated along an insulated conductor, in which, at the same time, a galvanic current is passing. This consideration has led me to utilise this kind of electricity. Consequently I have connected one of the extremities of the line to a Morse apparatus, and the other to an ordinary electrical machine and Leyden jar, with the idea that the sparks produced would pierce the band of paper. The frictional electricity might be made to pass to the printing point direct, and prevented circulating around the electro-magnet.

[This idea has been superseded by several English inventors, and at best is a clumsy contrivance.—Ed.]

Notices of Books.

A Treatise on Electricity and Magnetism. By James Clerk Maxwell, M.A., LL.D. Edin., F.R.SS. London and Edinburgh, Professor of Experimental Physics in the University of Cambridge. 2 vols. Oxford: The Clarendon Press. London: Macmillan and Co. 1873.

First Notice.

The combination of practical particular with theoretical generality is of the rarest occurrence. Yet this combination is an essential with the author of a treatise such as that before us. There is the deep and far-seeing mind of the generalist to be satisfied, as well as the mechanical detail of the construction of the applied instruments to be mastered. Much may be done in both branches; more often one or the other will outweigh in the balance. There will be contained in one work an excess of mathematical theorising; in another the subject will be merely described. The student of the first is debarred further progress by his want of appreciation of practical fitness; the other work will cram his memory with accounts of facts, but leave him incompetent to classify.

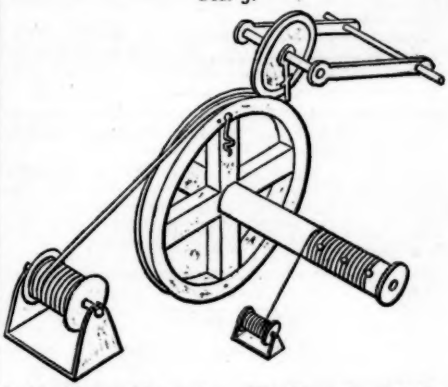
The results of such teachings are deplorable. A student is led to feel that practice and theory are not the good friends they ought to be, and that an attempt to reconcile them includes involution in the difficulty. Finally he discards theory or avoids realisation, and gives to the world an impossible scheme, or is crushed by cumbrous machinery.

In Prof. Maxwell's work we have a fit companion for the Newton upon our shelves, and one many of the pages of which would delight an artizan. Practical particulars are classified by well-tested theory, and again applications of theory are illustrated with apposite examples.

Before we proceed to discuss critically the merits of the work, we will give an example of its practical nature. Our quotation is from the chapter on Electromagnetic Instruments, and includes the paragraph "On Standard Galvanometers."

"In a standard galvanometer the strength of the current has to be determined from the force it exerts on the suspended magnet. Now the distribution of the magnetism within the magnet and the position of its centre when suspended are not capable of being determined with any great degree of accuracy. Hence it is necessary that the coil should be arranged so as to produce a field of force which is very nearly uniform throughout the whole space occupied by the magnet

Fig. 3.



during its possible motion. The dimensions of the coil must therefore in general be much larger than those of the magnet. By a proper arrangement of several coils the field of force within them may be made much more uniform than when one coil only is used, and the dimensions of the instrument may be thus reduced, and its sensibility increased. The errors of the linear measurements, however, introduce greater uncertainties into the values of the electrical constants for small instruments than for large ones. It is therefore best to determine the electrical constants of small instruments, not by direct measurement of their dimensions, but by an electrical comparison with a large standard instrument, of which the dimensions are more accurately known. In all standard galvanometers the coils are circular. The channel in which the coil is to be wound is carefully turned. Its breadth is made equal to some multiple, n, of the diameter of the covered wire. A hole is bored in the side of the channel where the wire is to enter, and one end of the covered wire is pushed out through this hole to form the inner connexion of the coil. The channel is placed on a lathe, and a wooden axis is fastened to it; see Fig. 3. The end of a long string is nailed to the

wooden axis at the same part of the circumference as the entrance of the wire. The whole is then turned round, and the wire is smoothly and regularly laid on the bottom of the channel till it is completely covered by n windings. During this process the string has been wound n times round the wooden axis, and a nail is driven into the string at the nth turn. The windings of the string should be kept exposed, so that they can easily be counted. The external circumference of this first layer of windings is then measured, and a new layer is begun, and so on till the proper number of layers has been wound on. The use of the string is to count the number of windings. If for any reason we have to unwind part of the coil the string is also unwound, so that we do not lose our reckoning of the actual number of windings of the coil. The nails serve to distinguish the number of windings in each layer. The measure of the circumference of each layer furnishes a test of the regularity of the winding, and enables us to calculate the electrical constants of the coil. For if we take the arithmetic mean of the circumferences of the channel and of the outer layer, and then add to the circumference of all the intermediate layers, and divide the sum by the number of layers, we shall obtain the mean circumference, and from this we can deduce the mean radius of the coil. The circumference of each layer may be measured by means of a steel-tape, or better by means of a graduated wheel, which rolls on the coil as the coil revolves in the process of winding. The value of the divisions of the tape or wheel must be ascertained by comparison with a straight scale."

Presently we shall deal more fully with the classification of this capital work; we felt it due to give in this issue some indication of its worth.

Our Schools and Colleges. By F. S. De Carteret-Bisson, F.R.G.S., &c. London: Simpkin, Marshall, and Co. 1872.

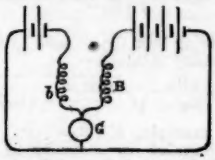
This guide to our schools and colleges we cordially recommend to the notice of the science-master, the student, and the parent. In it there will be found not only a list of the schools, but information as to the subjects taught, the teachers, and the terms.

Correspondence.

VOLTAIC CONSTANTS.

To the Editor of the Telegraphic Journal.

Sir,—Your number for April 15th contains an article on a "New Method of Determining Voltaic Constants." It is new, inasmuch as it is not to be found in any electrical books, as far as I am aware, but it is not entirely new. The method to which the diagrams 6, 7, and 8 refer was devised by me about three years ago, and it will be found in the *English Mechanic*, for July 5, 1872, p. 411. I would have published it sooner had I known it was new. A description and proof will be found there. I arrived at it nearly as M. Emile Lacoine has, by considering the potentials of the different points of a circuit containing two electromotive forces of the same sign. Perhaps a few remarks as to the value of this method may not be unacceptable. It gives very different results from Poggendorff's, and with reason. Poggendorff's method—in which the battery having the lesser electromotive force is not allowed to work—especially as improved on by Latimer Clark, most certainly is an exceedingly accurate way of comparing the electromotive forces of elements when not in action, which may be then very well called their *potentials*; but it is a notorious fact that these potentials fall more or less, generally more, when the batteries are called upon to make themselves useful. The so-called "new method" compares the *working* electromotive forces of batteries when in action through any desired resistance, and can on that account be of some value in practice. (What is the use of a battery having a very great potential, if it is only while sleeping?) Suppose we compare a number of Daniell's with an equal number of Leclanché's by the "new method." Referring to the figure (Fig. 8, p. 113), let the right-hand battery be the Leclanché's with the



big and lazy potentials, and the left the Daniell's with the smaller but more industrious potentials. Then—

$$\frac{L}{D} = \frac{\Delta B}{\Delta b}$$

expresses their relative electromotive forces. Now we may watch the behaviours of these batteries in an instructive manner by commencing with very high values of B and b, and for convenience we may make Δb constantly 100 ohms. At first ΔB will be found much higher, say 150, showing that the electromotive force of the Leclanché's is *at that moment* 50 per cent higher than the Daniell's; but by constantly taking 100 ohms away from b, the corresponding difference in B, namely ΔB, becomes smaller and smaller, and if we go on for a little while (for the Leclanché's soon get tired) ΔB will become actually less than 100 ohms, and if the batteries be left working, may fall much lower. We may reverse the process, but humpty-dumpty, when once fallen down, is hard to get up again, and ΔB will not become 150 again unless we give the Leclanché's a good rest. No two series of trials agree, however. What is the meaning of all this? What does it say? It says that the electromotive force of the Leclanché element, for continuous working, is anything between nothing and 1·2 or 1·3 times that of Daniell's. I have even seen the current of a Leclanché cell reverse itself after a few hours' hard work, but it partially recovered after a rest.—I am, &c.,

Oliver Heaviside.

Newcastle-on-Tyne, April 19, 1873.

SOCIETY OF TELEGRAPH ENGINEERS.

To the Editor of the Telegraphic Journal.

Sir,—Allow me to explain to your correspondent "Associate S. T. E." that the rules of the Institute of Civil Engineers, through whose courtesy we use the rooms in which our Society meets, do not allow us to admit female auditors, so that we cannot put the question of their admission to a vote.

We are not too conservative (*Qy.* exclusive), but too poor at present to entertain the question.

May I venture to ask your correspondent to try to think it possible that councils and authorities generally are not always actuated by "illiberal" motives when they are unable to meet his wishes.—I am, &c.,

A Member S. T. E.

London, April 26, 1873.

The Direct Spanish Telegraph Company have announced that telegraphic communication by the direct cable between the United Kingdom and Spain, *via* Bilbao, is restored, and the line again open for public traffic.

City Notes.

Mr. William Abbott informs us that during the first three months of this year the Atlantic telegraph receipts have attained to no less than £190,000 against £170,000 received in the corresponding period of last year, thus showing an increase of as much as 11 per cent.

The report of the British Australian Telegraph Company has been issued. The directors mention the terms of amalgamation with the British Indian and China Companies, which we gave in our March number. The title of the new Company is to be "The India, Australasia, and China Telegraph Company (Limited)," and it is to purchase the Tasmania and Victoria Submarine Telegraph Cable for £70,000 in shares. It is proposed to fix the nominal capital at £3,000,000, although only £1,997,500 will be required for the above purposes. The amalgamation is to date from the 1st January, 1873. The revenue account shows a profit of £8,043 5s. 3d., out of which the directors propose to distribute £7,500 in the payment of a bonus of 2s. 6d. per share, and to carry forward £543 to the reserve fund of the amalgamated company.

A meeting of the shareholders of the Anglo-American Telegraph Company (Limited), was held on the 23rd April, at the City Terminus Hotel, Cannon Street, for the purpose of ascertaining the opinions of the shareholders in favour of an amalgamation of the Company with the French Atlantic Cable Company. Mr. J. H. Lloyd, the chairman, having explained the object of the meeting, the following resolutions were unanimously passed:—"That in the opinion of this meeting an immediate consolidation of the Atlantic Companies is of vital importance, as a means of securing public confidence in telegraphic property, and maintaining regularly an uninterrupted communication between the two continents." "That this meeting regards the scheme of the Globe Telegraph Company as well calculated to accomplish the object contemplated by the first resolution, and as preferable to any other yet brought before the public." An influential committee was appointed to carry out the objects of the meeting, and thanks having been given to the chairman and directors, the meeting separated.

A meeting of the directors of the Globe Telegraph Company (Limited), was held on the 25th of April at the Company's offices, 66, Old Broad Street; present John Pender, Esq., M.P., chairman, Sir James Anderson, Julius Beer, Esq., Cyrus W. Field, Esq., Sir Daniel Gooch, Bart., M.P., Captain Sherard Osborn, C.B., C. W. Siemens, Esq., and Baron Julius de Reuter. After receiving and conferring with a deputation from a committee appointed by general meetings of the shareholders of the Anglo-American and French Atlantic Telegraph Companies held on the 23rd ult., the following resolution was unanimously adopted:—"The board of the Globe Telegraph Company having had submitted to them and duly considered the resolutions unanimously passed at the respective meetings of the shareholders of the Anglo-American Telegraphic Company and of the Société du Cable Transatlantique Francaise, and having been attended by a deputation from a committee appointed at those meetings—Resolved, that they are prepared to act upon those resolutions which are entirely in accordance with the principles which led to the formation of their Company, and to take prompt measures for giving effect thereto."—(Signed), John Pender (Chairman), 25th April, 1873.

It is announced by the Atlantic Telegraph Companies that in consequence of the breakage of the 1865 cable belonging to the Anglo-American Company, on March 11th, and of the French Atlantic Company's cable on the 20th inst., the directors of the joint board have reluctantly decided to raise their tariff between the United Kingdom and New York to 6s. per word, commencing on the 1st of May.

The following letter addressed to the shareholders of the French Transatlantique Company (Limited), explains terms of the proposed amalgamation:—

"26, Old Broad Street, E.C.,
April 29, 1873.

"Gentlemen,—With the view of giving the shareholders the earliest possible information with respect to the amalgamation from the 1st of May, of this, the Anglo-American and the Newfoundland Companies, I am instructed to acquaint you with the terms which the three companies have agreed to recommend to the acceptance of their shareholders. The Anglo-American Company will increase its capital to £7,000,000, and purchase the French and Newfoundland Companies; in this total capital—

£3,451,550 will represent the capital of the French Company (now £1,650,000).
2,548,450 will represent the capital of the Anglo-American Company (now £1,675,000).
1,000,000 will represent the capital of the Newfoundland Company (now £864,52c).

£7,000,000

"This Company's new cable will be now laid from Valentia to Heart's Content, Newfoundland, and from Placentia to Sydney (Cape Breton), in place of from Land's End to Halifax and New York. The shareholders in this Company will receive for each present share of £20 about £41 15s. in the shares of the amalgamated Company, subject to the payment by this Company of its existing debenture debt and the expenses of the liquidation, which may be estimated in round figures at £5 per share. As, however, the saving in cable, &c., made by the change of route will be considerable, two-thirds of which saving will accrue to the amalgamated Company, and one-third to this Company, it is expected a portion of this £5 will be provided for. The Newfoundland Company reserves its own land rights, and of the £1,000,000 accruing to it in the amalgamated Company, £135,480 will be placed in trust, to be handed over to the Newfoundland Company at the expiration of two years, should none of its present exclusive rights and privileges be withdrawn; otherwise, said £135,480 will revert to the amalgamated Company. The shareholders will be summoned together with the least possible delay.—I am gentlemen, your obedient servant, EATON T. CUMMINS, Secretary."

A special meeting is called for the 23rd inst., for the purpose of passing the necessary resolutions.

At the ordinary general meeting of the Great Northern Telegraph Company, held at Copenhagen on the 25th April, 1873, Count Sponneck presiding, Mr. C. F. Tietgen, the chairman of the Company, gave a detailed account of the Company's position. In first referring to the European lines, he had to report that the increase of traffic on the same had been very important, as it amounted to about 26½ per cent. compared with the previous year. The Company had obtained two valuable concessions. One from Sweden for a cable to be laid from Gothenburg to England, which would secure the Company a monopoly of the Swedish-English traffic; the other from France for a cable to be laid from Calais to Denmark, which would give the Company the monopoly of all traffic between France on the one side, and Denmark, Norway, Sweden, and Russia on the other. On the whole, he had to observe that the Company would now have a complete system of duplicate and monopoly lines in the North of Europe, the traffic on which could not be interfered with for the next 25 to 30 years. The Company's Chinese system had now been completed by

means of the cable carried into Amoy on the 22nd of February last, connecting that place with Hong-Kong to the south, and Shanghai to the north. The traffic on the Eastern lines had been greater than the previous year, and would have been considerably better but for the difficulties caused partly by the interruption of the Siberian land-lines, and partly by the interruptions of the Company's cables. A joint purse agreement has been entered into with the China Submarine Telegraph Company (Limited), so that after the 1st July, when it comes into operation, the gross receipts for the European and American traffic to and from China of the two companies will be equally divided between them. The advantages of the agreement of this Company is, that the tariff will be raised to £6 per message, and that the Company is insured against loss of traffic when interruptions on its lines occur. The Japan traffic has been kept out of the joint purse agreement, and may fairly be expected to revert in its entirety to this Company. Land-lines from Nagasaki to Simonosaki, Hiogo, Osaki, Yokohama, and Yeddo have been opened. International messages are however at present only accepted by the Japanese authorities at sender's risk. The Company's charge to Nagasaki remains as before £4 6s. from London, and £4 7s. from the country, and for the other stations it is £4 17s. from London, and £4 18s. from the country. To insure certainty of delivery, the Company will, on handing over the messages to the Japanese department at Nagasaki, simultaneously forward a copy by post to the receivers. The Chairman further remarked that the "Globe" future appeared latterly to have occupied the minds of some of the shareholders. There was no doubt that the principle which formed the basis of that great project was sound and correct; in fact it was the same principle which had guided this Company, viz., that of consolidation and self-insurance, and which formed the strength of the Company; but while he thus fully approved of the idea conceived by Mr. Cyrus W. Field, and which he hoped to see fully realised, he would remind the shareholders that, considering that they had been able to divide 5 per cent. for the past year under extraordinarily unfavourable circumstances, and upon a capital which had been increased on the occasion of its recent amalgamation, and considering that the Company had not only now an absolute monopoly of its European traffic, but had a good position in China, and particularly in Japan, where the Government did not appear inclined to grant other concessions than those granted to the Company, he did not think that there was any occasion for unduly pressing the question of being merged into the "Globe." The matter required patient and careful consideration, and when the proper time came, and the directors had in the meantime had an opportunity of directly ascertaining what the relations of other Companies were in the "Globe" scheme, what its organisation really was, and what terms might be fairly expected from it, he hoped (if the latter were acceptable) to come before them with proposals in the desired direction. To complete the extensions already referred to, the directors intended to dispose of the 25,000 shares, the issue of which had already been authorised at a previous meeting, and they intended to offer these shares to the present shareholders in proportion to their respective holdings. The directors have taken no *tantieme* or fees for the past year.

As announced, the Great Northern Telegraph Company are now offering to the existing shareholders a pro rata allotment of 25,000 new shares at par.

We have received a communication from the secretary of the Indo-European Telegraphic Company (Limited), announcing that notice has been received of the interruption of the cable of the British Indian Extension Telegraph Company between Madras and Penang. The Indian Government has sent a telegram stating that "Messages for the Far East, addressed 'Port Galle,' will be posted direct to destination. Messages for Far East containing no special directions will be posted to Singapore to be telegraphed onward." The words "Port Galle, Telegraph Singapore," need not therefore be inserted if the message is to go on from Singapore by telegraph. The following notice has also been received:—"Accumulated messages for Far East will go 'Port Galle' to Singapore by steamer leaving 17th inst.

The total traffic receipts of the Great Northern Telegraph Company have been during April, 1873, 219,918 francs; and in corresponding period of 1872, 181,496 francs. On the European lines—In 1873, 118,368 francs; in 1872, 105,866 francs. On the China and Japan lines—In 1873, 101,550 francs; in 1872, 75,630 francs. The cable between Shanghai and Nagasaki interrupted from 16th to 26th April. Siberian land-lines from 16th to 22nd April.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	May 13.
Stock	Anglo-American (Limited)	100	140—143
10	Brazilian Submarine..	3	1⅛—¼ dis.
10	Cuba	All	9¼—9⅜
10	Eastern Telegraph Co.	All	8¾—9¼
10	Ditto Extension	All	— —
10	Great Northern	All	10¾—11¼
20	Great Western	13	— —
25	Indo-European	All	16—18
10	Mediterranean Extension (Limited)	All	5¼—6
20	New York, Newfoundland, and London	20	21⅛—22
8	Reuter's..	All	10¼—11¼
20	Société Transatlantique Francaise..	All	32½—33½
Stock	Submarine	100	230—240
Cert.	Ditto Cables Trust	100	108—113
10	West India and Panama	All	6¼—7
10	Hooper's Telegraph Works	All	11¼—11⅝
50	India-Rubber and Gutta Percha ..	All	— —
*12	Telegraph Construction	All	32½—32⅝
Cert.	Ditto Ditto 3 years' Bonds	1 00	— —
20	Direct United States Cable	5	1 dis—par
1000 dls.	West Un. U.S. 7 per cent 1st M.B.	All	95—97

* Capital reduced by £3 per share out of profits.

At the meeting of the French Academy last week M. Jamin exhibited a magnet which he had constructed to carry upwards of twenty-two times its own weight: it weighs 2 kilogrammes and carries 45. Hitherto the greatest carrying power attained in artificial magnets has been from four to five times their own weight. M. Jamin has obtained this unprecedented result by substituting for the very thick plates hitherto employed, a sufficient number of very thin plates superposed on each other, and all thoroughly magnetised. One result of this achievement will be that the volume and weight of magneto-electric machines can now be diminished to a very great extent.

To Correspondents.

A. R. Granville.—Please look again at Lacoine's article. You are hypercritical as to the meaning of "whence."

Inquirer.—(1). Induction currents are now employed for working all kinds of instruments, but the source of power is generally permanent magnets. (2). Defective insulation has greater effect. (3). An account of Mance's method and its modifications in our next number. (4). Apply to Messrs. Taylor and Francis.

Curious.—Yes, the account was authentic; that is, from the hands of Sir William Thomson himself.

C. Minchew.—The patent is not yet printed.

BOOKS RECEIVED.

"Electricity and Magnetism." By Fleeming Jenkin, F.R.SS. L. and E., M.I.C.E. Longmans and Co. 1873.

"Apparato Semaforico Girante."

"On Electric Railway Signalling." By William Henry Preece C.E.

"Bulletino Telegrafico."